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APPROPRIATE OPPORTUNITIES AS WELL AS APPROPRIATE TECHNOLOGY

by Niels Roling

There is persistent evidence that agricultural extension in the developing world is not reaching the poorer farmers and that extension and other agencies tend to focus instead on the better-off farmers who probably represent not more than 20 per cent of the total. When asked the average farm size in their area of work, extension agents usually give a higher average than the actual one, thus revealing their target clientele. If an extension service has no specified target categories and claims to service the farmer, one can be sure that it serves the top 20 per cent of farmers. If an extension officer say he is reaching the small farmers, one can be sure that he is reaching the three hectare farms while the majority consist of one hectare or less. In one country, extension workers claimed that 100 per cent of the farmers grew hybrid maize. A random sample survey indicated that the actual proportion was 31 per cent.

Many extension professionals justify a focus on the top farmers, claiming that diffusion processes ensure that information introduced among the more progressive farmers will automatically spread to the others. It is, however, important to distinguish, as did E.M. Rogers in his book Diffusion of Innovations, between diffusion as a process and diffusion (or dissemination) as an activity.

Diffusion is, first of all, a process that takes place whether extension has a hand in it or not. Cocoa was adopted as a cash crop by thousands of small farmers in Ghana and Nigeria without the assistance of a single extension agent. Novel ideas or practices tend to be diffused among those who think they can benefit from them and who have both the knowledge and the means to apply them. This process has been the object of much research whose results have been interpreted differently over time. Earlier research emphasized innovativeness (or relative earliness in adoption) as a socio-psychological trait. Earlier adopters were held to be more venturesome, while later adopters were seen as tending to stare fixedly in the rear-view mirror. The last to adopt were called "laggards", their late adoption being their own fault.

This interpretation tended to reinforce existing forms of diffusion as an activity. After all, it seemed natural to begin without those who were quick to follow advice and to leave the conversion of the slow ones to autonomous social processes. It was believed that this

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progressive farmer strategy" would allow one extension worker to cater for hundreds or even thousands of farmers. However, when the rate of change began to accelerate and when it became obvious, especially from evaluations of the green revolution, that whole categories of small farmers were not being reached by diffusion processes, the interpretation of diffusion research results changed. Instead of the venture someness of the earlier adopters, their relatively higher access to resources (which the data had always shown) was now emphasized and the "laggards" were seen as people with very little access to resources. As an article by N. Caplan and S.D. Nelson in the American Psychologist pointed out more than 10 years ago, "person blame" had been replaced by "system blame".

Horizontal diffusion This new interpretation created a gap between extension practice and its justification. The findings of diffusion research showed that diffusion as an activity benefitted especially those who already had a high level of access to resources. The "progressive farmer strategy" began to be seen as contributing to the rapidly increasing gap between rich and poor.

The new interpretation also raised questions about previous theories of innovation diffusion. Hitherto the social system within which an innovation was to be diffused had been assumed to be homogeneous, so that the innovation was equally relevant for all members of the system. Differences in socio-psychological innovativeness explained the differences in readiness to adopt.

Occasionally farmers can, for all practical purposes, be assumed to be homogeneous in terms of availability of resources, soil type, climate, and so forth. One example is in the new polders of the Netherlands, where carefully selected farmers have been settled for some time on uniform plots. Large differences that have been observed in these farmers' achievements can indeed be attributed to differences in entrepreneurship and professionalism among farmers.

However, such homogeneity cannot usually be assumed. Differences in access to resources and capacity to innovate emerge as important causes of the breakdown of diffusion processes. When systems, such as farming communities, are heterogeneous in terms of access to resources, the same innovation cannot be assumed to be of relevance to all its members. In such a system, "horizontal" diffusion may take place easily enough, but "vertical" diffusion is unlikely.

This development in diffusion research has pointed to the need for changes in the current practice of diffusion as an activity, introducing the notion that rural populations

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should be segmented into homogeneous target categories within which horizontal diffusion of technology appropriate to that category could take place.

Technology is often defined as the application of science, testimony to our earlier awe for science as the source of progress. But Harold Las-wells diffnition seems more in line with modern usage: "Technology is the ensemble of practices by which one uses available resources in order to achieve certain valued ends."

Under this definition, the practices of Bushmen who survive in the Kalahari Desert can also be called technology, although they are based on science only to the extent that a people's collective experience accumulated and systematically transmitted over millenia can be called a science.

The objectives that people have, the production decisions that farmers make are strongly influenced by the life-cycle of the rural household. Research by Michel Petit, reported by the European Review of Agricultural Economics in 1976, has shown that young households with growing children, households with young sons working on the farm, and households with two generations on the farm were those with the largest land holdings, the highest incomes, and the most contact with extension agencies. Apparently their production objectives make them "progressive farmers". Other households, composed of bachelors or elderly couples with no successors had very different production objectives and needed different types of technology.

Valid recommendations. Important as objectives may be in determining technology, emphasis thus far has been more on available resources. Institutions such as CIMMYT (the International Centre for Maize and Wheat Improvement) that have tried to classify rural populations in order to develop appropriate technology have identified the following characteristics of resources:(1) ecology (rainfall soil type, temperature, etc); (2) access (farm size, availability of labour); (3) infrastructure (market opportunities, roads, rural electricity, etc.). These three clusters of variables are used to divide a rural population into homogeneous target categories, which CIMMYT has labelled "recommendation domains" (that is to say, in each category a uniform set of agricultural recommendations is valid). The new approach, struggling for a foothold in the temples of international agricultural research, does not merely translate results of agricultural research conducted in experimental stations into recommendations for the benefit of farmers who have sufficient resources to be able to use them. Rather, it begins with the rural population, which it divides into homogeneous categories; it studies farmers within these categories in depth, often involving them actively in the research.

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Only then does it call upon the assistance of agricultural research to identfy appropriate solutions and strategies. This farming systems research thus has two phases: first, the identification of the homogeneous recommendation domains; and, second, analysis of farmers and farming in selected target domains.

Farming systems research has been developed in response to the challenge posed by the deteriorating conditions for 200 million farmers who have less than one hectare of rain-fed land and who have only extremely small margins to finance any improvements. They lack the reserves for overcoming crop failure; the death of a single animal or the erosion of a bit of land can be, as Robert Chambers has said, "a poverty ratchet on an irreversible course to greater misery". To help such farmers by means of agricultural information requires that the recommendations be carefully adapted to the situation of the farmer.

Another factor in the development of farming systems research was the discovery that many assumptions about rural households that had been used as a basis in project planning were completely invalid. The usual assumption was that rural households are like the Western ideal family farm: the father is head of the farm, participates in the economic world outside and takes all decisions that pertain to it, while the mother reigns in the private domain and has little to say in the external one. Of course, she helps a bit by doing such light female work as feeding chickens and picking strawberries. There is great harmony of interest between man and wife. And what the man earns outside is used for upkeep of the household.

Supply-side fashion: The consequences of applying this model in settlement schemes, mechanization projects, and the like, have often been disastrous. Women and children often have a completely different role in farming systems in developing countries (and many in industrial countries, for that matter). They frequently have crucial managerial or decision-making functions in production, or are entirely responsible for a productive enterprise. There may be little or no intra-household distribution of resources. The whole notion of household or family may be tenuous to begin with, as decisions about production or consumption are taken at other levels or within different units. Farming systems research is capable of revealing the true nature of family systems as well as the changes that take place in them when they are incorporated into market economies.

Farming systems research has by no means become standard practice as yet in agricultural research institutions or extension services. The introduction of technology countinues to be planned in a supply-side fashion, without much knowledge of the population segments that are supposed to benefit, let alone permitting them to participate in planning and technology development. Extension handbooks, it seems to me, give more attention extension communication methods and media than to content. The transformation of research results into appropriate recommendations receives little attention in the training of either agricultural researchers or extension specialists.

While the formulation of messages for farmers from agricultural recommendations is only one stage of a complicated process of transformation, failure to recognize the role and nature of this activity can lead to completely unrealisitic practices. In one country it was common practice to distribute the annual report of the agricultural research department to district agricultural officers with the intention that these findings would be "passed on" to farmers. To understand why there would be little prospect of a busy administrative official's being capable of carrying out such an assignment, it is necessary to dissect the whole transformation process into its component parts.

From this it will be seen that:

-Formulating recommendations combines the results of agricultural research with those of farming systems research into specification for the operations required to achieve certain improvements in the target farming community;

-Adaptive field tests of these recommendation assess the claims and benefits, for both farmers and the agencies who are to promote the implementation. In the case of farmers, it is important to assess claims and benefits not only for the farm unit or the male head of the family, but for women and children as well. Many projects have foundered because they failed to take into account the claims that implementation made upon available time of women.

-Adapted recommendations, formulated on the basis of results from the adaptive testing, represent the product that extension services can now promote on a large scale within the target recommendation domain. It is at this point that the traditional job of extension begins: demonstrtions, farm visits, group meetings, articles in the press, radio farm forums, etc;

-Formulating messages requires recognition of the need to consider the characteristics of the target category, such as literacy and previous knowledge. A single recommendation can thus lead to the formulation of a number of messages, each serving a different function, such as; creating awareness, providing information for assessment, persuasion by linking the promoted behaviour to needs of the target category, instruction(explaining how to do it), evaluation (helping to assess the effect), improving entrepreneurial capacity and increasing self-confidence.

However, the degree of utilization of agricultural knowledge is dependent not only on the impact of extension efforts. If extension workers' salaries were based on the extent to which farmers followed their recommendations, there

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would undoubtedly be protests that although many farmers were perfectly informed, product prices were too low to make adoption attractive, or inputs were not available, or farmers lacked capital or credit to make the required investments. Thus the defree of utilization depends on a whole set of conditions, an agricultural development mix, which includes effective extension.

It is possible only to a limited extent to develop the information input sufficiently so that it takes account of the absence of other elements in the mix, while still ensuring that members of the target category will benefit from using the recommended practice. Farming communities that have survived for generation in a specific environment have usually worked out a farming system that defies improvement by a simple input of knowledge alone. To assume otherwise seriously understimates the achievements of trial-and-error research by generations of people whose life depended on the outcome. Indeed, farmers' own knowledge and the adaptations or improvements they have developed constitute an important source of innovation and self-renewal. The creation of new opportunities, involving elements of the mix other than extension, is less a matter of benevolent government agencies than of lobbying by farmers and their representatives. It is a matter of exerting user control to influence prices and market opportunities, to pressure research and extension services into providing appropriate information, to make their problems known among policy makers.

A crucial ingredient. It is hard to imagine a situation in whcih agriculture has developed where farmers have not formed some effective "utilizer system". One might conclude that agricultural development can best be accelerated by fostering the growth of such utilizer systems, a conclusion which stands in sharp contrast to the usual emphasis on strengthening of the one-sided intervention powers of various government agencies as a prerequisite to agricultural development.

It should be noted, however, that producer lobbying power has usually consisted of, or represented, those farmers with considerable access to resources, and by the same token the lobbying effort usually seeks to create opportunities for larger farmers. Strategies intended to assist smaller farmers also depend just as much on the creation of appropriate opportunities as on the delivery of appropriate technology and the consistent development of such opportunities requires that small farmers develop their own effective lobbies. A crucial ingredient to small.-farmer development is what Dr. Leonard called, in his Reaching the Peasant Farmer, "the squawk factor" or "claims from below". If service agencies hope to extend small-

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farmer approaches to a significantly larger scale they must be prepared to respond to an increasing capacity of the rural poor to make claims; they must create the space for a gradual shift of their constituency from the most resource-endowed to the less well endowed.

Obviously such a shift in constituency encompasses political dimensions that ought not to be understimated. In many cases governments allocate resources to extension and other service agencies to create an instrument for agricultural development. The objective is often not so much the welfare of the farmers as it is the creation of a surplus for national development, which has often been equated with urban-elite development. In the short run, such a policy is much easier to implement with a few larger farmers than with thousands of small ones.

However, the recognition by agencies such as FAO, as detailed for instance in the "Small Farmers' Development Manual", that the creation of utilizer systems or constituencies among the poor is an essential prerequisite for effectively assisting them has led to the emergence of a participatory strategy that seems to hold considerable promise.

(Ceres, 17, 1 ,(Jan.- Feb.,1984), pp 15-19)

MAJOR WATER PROBLEMS FACING THE WORLD

BY Asit K. Biswas

The Role of water in the overall development process of countries has become an increasingly important issue during the last decade due to several events, some natural and others man-made. Firstly, severe droughts and floods in many parts of the world during the early 1970s contributed to a major food crisis. During the World Food Conference (Rome, 1974), convened to propose solutions to such a major global crisis (Biswas and Biswas, 1975), it became evident during the deliberations that proper control and management of water is absolutely essential not only for further horizontal expansion of agriculture, but also for increasing the overall yield from existing cultivated land.

Secondly, the steadily increasing prices of fossil fuels, especially oil, focussed international attention on the development of hydroelectric power (a renewable resource) as a viable source of additional electric power generation. This was a departure from the practices of the 1950s and '60s, when many countries preferred to construct power plants with a fossil fuel base because of the economic advantages they offered and their easy availability.

Thirdly, the Lima Declaration of the United Nations Industrial Development Organization recommended that, by the year 2000, 25 per cent of global industrial production should take place in developing countries. If this is to be achieved, more water will be required for further industrial development. Fourthly, the UN Conference on Human Settlements (Biswas, M.R., 1978) and on Water (Biswas, M.R., 1977) emphasized the plight of people in developing countries, especially in rural areas, who do not have access to safe drinking water. On the recommendation of the 1977 Water Conference, the decade 1981-1990 was officially declared the International Drinking Water Supply and Sanitation Decade, by the General Assembly of the United Nations (Biswas, 1981a).

Finally, pollution of inland and coastal water bodies and of the oceans has attracted increasing national and international concern, partly through the work of the United Nations Environment Programme (UNEP), which itself was created in the early 1970s at the UN Conference on the Human Environment (Stockholm, 1972). All these events, individually and collectively, clearly indicated the urgent necessity of sustainable water development to ensure optimal utilization of available water, as well as maintnance of its quality.

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Major Water Problems facing the world

The author has carried out a number of water resources development studies for the United Nations Water Conference (Piswas, 1975), held at Mar del Plata, Argentina, in 1977; for various United Nations agencies and international organizations. Based on these studies, the major water problems facing the world are:

(1) Provision of safe drinking water.

(2) Water requirements for further agricultural, hydro-electric and industrial developments.

(3) Sustainability of water development projects.

(4) Development of water resources shared by two or more states.

These priority areas have been selected on the basis of three major criteria:

(1) Global interest and thus, affecting a large number of people.

(2) Immediate nature of the problem.

(3) Availability of adequate information on the magnitude and extent of the problems, as well as knowledge of the steps to be taken for their solution.

Provision of Safe Drinking Water

A large number of people in developing countries do not have access to clean water. Reliable figures on the exact number do not exist. But an aggregate of selected 'raw' estimates of varying degrees of accuracy from many developing countries is provided by their governments and compiled by the World Health Organization (WHO) of the United Nations. Its most comprehensive recent survey, as of the end of 1975, rested on questionnaires returned by 71 developing countries, which unfortunately did not include the most populous country in the world -- the People's Republic of China.

According to this survey, 77 per cent of the urban population had access to piped water supply through house connections or standpipes. The situation, as to be expected was significantly worse for rural communities, where 73 per cent did not have access, to safe water (WHO, 1976). The report further indicated that the number of people with access to public water supply schemes in developing countries increased from about 400 million to some 750 million

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during the period 1970 to 1975. Despite this dramatic increase, however, the number of people not receiving clean water remained almost the same, due to rapid population growth.

A later WHO estimate for 1980 (even more unreliable than the 1975 survey) indicated that the percentage of urban and rural populations having access to clean water had increased to 75 and 29 per cent respectively (WHO, 1981). Since rural populations predominate in developing countries, the percentage of the total population having such access increased from 38 per cent to 43 per cent during the five-year period.

Two important issues emerge from a review of the limited information available. Firstly, access to safe drinking water is, at present, essentially a rural rather than an urban problem. This situation has developed over the years not only because of distinct urban bias on the part of national planners, but also due to existing political and institutional pressures. The élite who hold power are urban-based and their policies, in spite of the rhetoric, clearly favour the urban areas, where their power centres normally lie. The fact that rural people tend to be poor, illiterate and malnourished, and thus have very little political power, does not help. The direct beneficiaries of national policies are often the educated urban elite who are in power. In addition, inadequate planning, insufficient budget, incomplete execution of plans, limited appreciation of the problems of rural people and a lack of understanding and emphasis by donor countries and agencies - all these factors have not helped the cause of water supply in rural areas.

Secondly, from the existing scattered data available, it must be concluded that, while major advances have been made during the past 20 years in increasing the percentage of people having access to clean water in most developing countries, there have also been declines in some regions. WHO carried out three surveys in 1962, 1970 and 1975. The data obtained are not strictly intercomparable, since the numbers of countries surveyed have changed with time: 75 countries in 1962, 91 in 1970 and 71 in 1975. Furthermore, an examination of 1970 and 1975 data indicates that even the individual national estimates of many countries differ significantly from one period to another due to major differences in enumeration, presumably because of different people involved and/or different techniques used.

In spite of these constraints, when changes in percentages of urban population served during the 1962 to 1970 period are considered, the situation in the South-

East Asian and East Asian regions improved remarkably, both by more than 20 percent. In contrast, the situation was much different in the Latin American and Caribbean region, where a ten percent decline was registered. Similarly, in the 1970 to 1975 period, South-East Asia, East Asia and the Western Pacific showed most improvement (15 percent or more) but, unfortunately, in Africa, south of the Sahara, the situation deteriorated and showed a two percent decline.

As this deplorable situation of water availability became more clearly recognized, a series of goals and objectives were approved at intergovernmental level during the last decade (Biswas, 1981a). Among these was the United Nations Conference on Human Settlements, commonly known as Habitat (Vancouver, 1976), which approved a sweeping goal of safe water for all by 1990, if possible. The following year, the United Nations Water Conference approved that all peoples have the right of access to drinking water in quantities and of a quality equal to their basic needs. It recommended that 'priority attention' should be given to the segments of the population in greatest need. It re-endorsed the Habitat target of clean water for all by 1990 and urged countries to develop suitable national plans and programmes to meet the targets by 1980. It further recommended that the decade 1981-1990 should be designated the International Drinking Water Supply and Sanitation Decade (Biswas, 1978).

A realistic estimate of the chances of success in achieving the goals of the Decade has to be that they are not very great for a variety of reasons which have been discussed elsewhere (Biswas, 1981a). Goals and targets are easy to design and resolutions are easy to pass. But resounding and pious declarations are not enough by themselves: they must be implemented. The Decade's objective, of clean water for all by 1990, should at best be considered as the target to be aimed at (and preferably achieved) by as many countries as possible. It should be considered as the beginning of more intensified programmes and activities, with the first stage being the provision of even intermittent water supply in urban areas and standpipes in rural areas. The final phase could be the provision of running water in all homes.

Based on current trends, clean water and sanitation for all by 1990 may appear like the impossible dream sought by Don Quixote, the Man from La Mancha. But, for many citizens of the world, this dream could become a reality with intensified efforts and that alone is worthwhile. This no doubt an important priority area.

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Water Requirements for Further Agricultural, Hydroelectric and Industrial Developments

While availability of safe drinking water is very important, the agricultural and industrial sectors, on a quantitative basis, are the major users of water, significantly more than domestic water use. On a global basis, agriculture is the largest user of water, accounting for approximately 80 per cent of global consumption (Biswas, 1978, 1979). Industrial water use is a major consideration in certain countries like Canada, where it accounts for nearly 84 per cent of total withdrawal. The corresponding figure for the United States is about 40 per cent. However, for a developing country like India industrial water use accounts for only about one per cent of total withdrawal (Biswas, 1979).

Without appropriate water control, it will not be possible to solve the world's food crisis.....

In 1975, the total area irrigated in the world amounted to 223 million hectares (ha), of which 92 million ha were in developing countries (FAO, 1978). The amount of water used by irrigated crops is nearly 1,300,000 million m^3 but because of losses, the amount used increases to almost 3,000,000 million m^3. (This aspect will be discussed later). Only some 15 per cent of the world's croplands are irrigated, yet they contribute 30-40 per cent of all agricultural production.

By 1990, it is estimated that the total area irrigated in the world will increase to 273 million ha, of which 119 million ha would be in developing countries (FAO, 1978). Expanding and maintaining irrigated areas is going to be a challenging task for the future; its magnitude can be judged by the following requirements for the developing market-economy countries only(FAO, 1978):

- 22.5 million ha of new irrigation
- 45.0 million ha of irrigation improvement
- 78.2 million ha of drainage improvement, including 52.4 million ha on irrigated land
- 438.000 million m^3 of additional water
- US$97,800 million of investment at 1975 prices

Industrial developments will also require more water in the future. According to the targets set for the Second Development Decade of the United Nations, industry in developing countries was expected to grow at an annual average rate of 8 per cent. The Lima Declaration and Plan of Action recommends that the total share of manufacturing output of developing countries should increase to 25 per cent by the year 2000. If the Lima target is to be met,

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industrial water requirements for developing countries will increase substantially. This would have major impacts not only on the quantity of water used, but also on the quality of water due to the discharge of effluents. Much of the water required by the industrial sector (nearly 60 to 80 per cent) need not be of a high quality since it is used primarily for cooling. However, such enormous discharges of heated water could aggravate thermal pollution problems.

Hydroelectric power is a major objective of water developments. Currently, it accounts for 70 to nearly 100 per cent of all electricity generated in countries as diverse as Brazil, Canada, Morocco, Norway and Sri Lanka. Hydropower has recently become attractive for many countries, especially in terms of increasing self-reliance and reducing the the national balance-of-payments problem caused by importing energy-producing materials. While the capital costs for hydro developments are high, running costs are minimal. Furthermore, generation of electricity does not consume water, which can then be used for agricultural, industrial and other purposes.

The potential for hydropower has been realized to a great extent in North America and Europe (including the USSR). But there is a vast potential waiting to be developed in Africa, Asia and Latin America. Africa's hydro potential is the least developed, its current annual production being only 4.3 per cent of the potential output. Thus, in Africa, the trend towards increasing emphasis on hydropower generation, in preference to other forms of energy development, is likely to continue for the foreseeable future.

Sustainability of Water Development Projects:

Water development, like any other type of development, must be sustainable over the long term and the social and environmental costs from such developments should be kept to a minimum. Currently, over-irrigation is endemic and not exactly an unknown practice in both developed and developing countries. Much water brought to the fields, after major capital expenditure, is thus wasted; this practice contributes to the development of adverse environmental problems, such as an increase in groundwater tables and salinity levels. Ultimately, it reduces the yield of agricultural products, thus undermining the very objective for which the initial development was undertaken.

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There are many cases where water development projects, designed to increase irrigated agriculture, have contributed to problems that eventually reduced the total food production. Among such problems are the deterioration of soil fertility and eventual loss of good arable land due to the progressive development of salinity, alkalinity or waterlogging. For example, at one time Pakistan alone was losing 24,280 ha of fertile cropland every year; currently, nearly 10 per cent of the total Peruvian agricultural area is affected by land degradation due to salinization. Other major areas affected by salinization are the Helmud Valley in Afghanistan; the Punjab and Indus Valleys in the Indian sub-continent; Mexicali Valley in Mexico; and the Euphrates and Tigris Basins in Syria and Iraq (Biswas, M.R. 1979a, 1979b).

Groundwater resources have been extensively developed in many countries in recent years, primarily for irrigation. If such developments are based on the fundamental hydrological principle that the rate of abstraction should be equal to or less than the rate of recharge, then they are sustainable. Unfortunately, in many instances, the rate of abstraction of groundwater far exceeds the rate of recharge, thus contributing to serious over-exploitation. Such practices result in not only a continual lowering of the watertable, but also often contribute to decreased pressure in aquifers, changes in rate and direction of flow, salt water intrusion and land subsidence. Continued over-exploitation, coupled with high energy costs, could mean that the watertable is lowered to such an extent that it is no longer economic to pump the water for irrigation. Agricultural developments in such instances can only be treated as temporary phenomena, since production declines significantly once water availability is reduced. This situation has already occurred in many parts of the world. For example, recent data from groundwater monitoring in the province of Tamil Nadu in India indicate that at least 37 observation wells had a net fall of more than 6 metres during a mere six-year period, between January 1973 and January 1979. One well recorded a net fall of as high as 16.40 metres, which means an average lowering of 32.77 cm per month - a very high figure viewed from any direction (Srinivasan, 1979). With increasing emphasis on the use of groundwater for the further horizontal and vertical expansion of agriculture, it is imperative that the developments planned are sustainable.

Development of Water Resources shared by two or more States:

With increasing demands on water for different purposes, conflicts between nations sharing the same river and lake basins or aquifers are likely to intensify in

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the future (Zamm, 1983). The magnitude of the problems of developing shared water resources has not yet been fully realized. National boundaries frequently divide drainage basins and conflicts between nations often arise due to competing demands over limited supplies of available water and/or deterioration of water quality through waste discharges. On a global basis, there are 214 river or lake basins that are shared by two or more countries (Biswas, 1981b). These are distributed as follows:

Africa	57
Asia	40
Europe	48
North and Central America	33
South America	36
Total	214

There are nine river and lake basins which are shared by six or more countries. Arranged in descending order according to the number of countries involved, these are:

Danube-12 Countries; Niger-10 countries; Nile-9 countries; Zaire-9 countries; Rhine-8 countries; Zambezi-8 countries; Amazon-7 countries; Lake Chad-6 countries; and Mekong-6 countries.

Viewed from a different perspective, there are at least 40countries where a minimum of 80 per cent of the total area of the country falls within an international river basin.

During the past decade, several long-standing conflicts have emerged over the development of international rivers, such as the Colorado (United States and Mexico), Euphrates (Syria and Iraq), Ganges (India and Bangladesh), Indus (India and Pakistan), Jordan (Israel and Jordan) and La Plata (Brazil and Argentina). With increasing population and the need for further economic development, pressures for development of a country's resources will become even more critical. For example, the Ganges Basin alone may have to support some 500 million people by the year 2000. With such pressures, the potential for conflicts between nations will, in all probability, increase dramatically.

There is thus an urgent need to identify existing and emerging conflicts and to develop guidelines and procedures for resolving them. International organizations like the United Nations have had only serious attempts or studies for the resolution of such conflicts.

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Strategies

In order to ensure sustainable development in the four priority areas mentioned, several strategies have to be adopted. Only the more important strategic considerations will be discussed here due to limited space.

Multidimensional problems

Many of the current strategies for water resources are based on the primary objective of solving a specific narrow problem on the principle of reductionism. Strategies are generally developed by those professions that tend to dominate the problem. This approach has contributed to more problems since nature is not organized in the same way as are professions. For example, one hears of engineering problems, biological problems, social problems, chemical problems, medical problems and so on. In a real world, of course, nothing can be further from the truth. A problem is a problem and the addition of the professional adjective only indicates our way of viewing and analysing that problem. The method of analysis depends on the analyst's education, training and background, all of which can introduce significant biases in the resulting analyses on which strategies for solutions are based.

Let us consider the first priority area discussed - community water supply. It has been mostly argued that if the quality of water supply is improved, there would be tremendous health benefits. This is not surprising since public health workers dominate this field. Contrary to all the pious statements made in various international fora, it is not possible at present to define precisely the relationship between quality of water and public health. Other broad and diverse elements are also important, such as housing, comprehensive health services, availability of nutritious food, energy, education and transportation. Many health and other related benefits that most people now expect from the provision of clean water are unlikely to accrue unless a broader view of the problem is taken.

Current studies in Bangladesh, Guatemala, Lesotho and the United States have failed to demonstrate that improvements in water quality have a marked impact on the incidence of diarrhoeal disease. The reasons for such findings are complex and are discussed in detail elsewhere (Blaxna, 1983). Suffice it to say that water is not the only means through which faecal-oral diseases (like cholera, typhoid, diarrhoeas, dysenteries or hepatitis) are transmitted. Furthermore, from the empirical studies available so far, it is becoming increasingly

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evident that the quantity of water used has an important impact on health. And yet the current practice of providing standpipes does not appear to increase water use patterns in rural areas.

Improving water quality via standpipes does not automatically improve personal hygiene practices that have developed over centuries. Only in a few instances, where potable rural water supply schemes have been developed, have bathing and laundry facilities also been provided. People thus continue to use contaminated sources for those purposes and infection continues. The importance of educating the public about good hygienic practices cannot be overemphasized. At present, such services in rural areas are mostly non-existent, even for those households looking for information. Unfortunately, this simple lesson has still not been fully grasped by most national and international agencies active in this area.

It should also be pointed out that, in most cases, there is no provision for drainage of spilled water at the standpipes, with the result that pools of stagnant water - a common sight in most developing countries - have become breeding grounds for mosquitoes and other insects. This in effect means trading water-borne for mosquito-borne diseases!

Encouraging the efficient use of water

With increasing water requirements, it is essential that strategies encourage the efficient use of water. Such strategies are especially relevant for the agricultural and industrial sectors, where there is enormous potential for saving water.

There is no doubt that, at present, water use in the largest sector - agriculture - is inefficient. As previously stated, 1.3×10^{12} m^3 of water is used globally for irrigating crops, for which 3×10^{12} m^3 of water has to be withdrawn. In other words, 57 per cent of the total water withdrawn is lost. And this is likely to be a conservative estimate! The actual losses are probably much higher.

One of the most inefficient aspects of existing irrigation systems is often the section where water is transferred from canal outlets to farms. It has almost become a 'no-man's land' due to undefined responsibility, which in turn contributes to improper design at first and, later, to unsatisfactory operation and maintenance. While much research has been carried out on losses from canals, very little has been done on losses from such sections of the irrigation system. Studies carried out

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on 40 such sections in the Indus Basin during 1975 and 1976 indicated losses ranging from 33 to 65 per cent, with an average of 47 per cent. Another investigation on 60 sections, carried out in 1977 and 1978 by the Water and Power Development Authority of Pakistan, indicated similar losses (Biswas, 1981b). The magnitude of this problem can best be realized by considering the case of well-lined canals, which are expensive to construct but have operating efficiencies of 70 to 80 per cent. When the efficiency of the total system is considered (that is, lined canals in conjunction with the inefficient section from canal outlets to farms), the total efficiency is of the order of 20 to 50 per cent. This means that even for expensive, lined and well-maintained canal systems, less than one-quarter of the water released from a reservoir reaches the crops being irrigated. The Central Board of Irrigation and Power of India recommend that channels above 1,000 cusecs (304.9 m^3/sec) should be lined(CBIP,1975).

A major consequence of this sad state of affairs is that engineers have accepted this inefficient system, at least implicitly. During the planning of irrigation projects, total water requirements are generally calculated by multiplying the extent of the total area to be irrigated by the water required per hectare. The water requirement per hectare is generally estimated on the basis of existing systems where, as we have seen, major amounts of water released from reservoirs are lost. Accordingly, overall estimates of the water requirements for irrigation are invariably high - certainly significantly higher than necessary - and this inefficient system is condoned and perpetuated. In other words, most irrigation systems designed so far are generally inefficient and use far more water than is needed. Unfortunately, instead of attempting to make irrigation systems more efficient and then maintain them at such high levels, engineers are constantly looking for new sources of water instead.

Costly alternatives are often considered, such as interbasin water transfer, when such major and expensive projects are not essential (Biswas, 1981c). Cheaper alternatives are available and can be implemented within a significantly shorter time frame with the indigenous labour force and expertise, by simply improving the existing systems. Furthermore, when new projects are developed, unless special efforts are made to maintain their efficiencies at high levels, their effectiveness will decline with time and the vicious circle continues. Viewed from a different standpoint, present irrigation systems are highly efficient in recharging groundwater!

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While the potential for saving irrigation water is extremely high, water can be used more efficiently in other sectors as well. For example, nearly 60 to 80 per cent of the water required for industrial processing is for cooling; by extensive recirculation, the total water requirements can be drastically reduced. Thus, water requirements per ton of soap manufacturing vary from 960 to 37,000 tons, the lower figure being only 2.5 per cent of the of the former. Similar savings in water can be achieved with other industrial processes. Accordingly, strategies promoting water conservation will become increasingly important in the future.

Better Management of Water Resources Systems

Much emphasis in the past has been placed on the planning and construction of water resources systems; management aspects have not received adequate attention. There are many reasons for this neglect but only two will be mentioned here. Firstly, the engineering profession tends to dominate the water field and seem to be more interested in the design and construction of new projects rather than actually managing them. Design and construction aspects are considered to be a challenge, whereas maintenance and management do not appear to be considered so.

Secondly, aid agencies prefer construction of major projects like dams. Such projects are more appealing to donor countries since much of the aid can be used for consultancies, construction contracts, purchase of equipment and so on. This means that a major percentage of the funds expended on the projects ultimately return to the donor country. For example, current estimates indicate that 70 per cent of aid funds in Great Britain return to that country. Furthermore, politicians of both donor and recipient countries can get more political mileage out of large projects compared to those that deal with management only.

The return from improved management practices can be demonstrated from two recent well-documented experiments. The first was at the International Rice Research Institute in the Philippines, where modest changes were made in the water-distribution procedures for a distributory commanding 5,700 ha (Valera and Wickham, 1978). Some minor technical improvements were also made. These had the effect of increasing rice production by 94 per cent over a two-year period. The production significantly increased by 149 per cent in the tail section. Similarly in Sri Lanka, Shanmugarajah and Athukorale (1978) report a 90 per cent increase in rice production for an area of 3,000 ha irrigated by a tank. This was achieved by better management.

(Int. Journal of Water Resources Development, 1, 1 pp. 1 -12)

BASIC RESEARCH IN INDIA

by S.C. Dutta Roy

Basic Versus Applied Research

Of late, much is being talked about socalled applied research and relevance of research to national needs, and often, research fund administrators are happy if a research ends up in a piece of equipment which performs some job, however ineffectively it may be, as compared to what has already existed in the developed countries, may be since a decade ago. Such administrators find it fashionable to club all basic research as 'academic' and therefore useless persuits. This, in my opinion, is a dangerous trend, and if allowed to persist, will keep India continually lagging behind, more and more, in the state-of-the art in science and technology in the developed countries. It is an elementary fact, although frequently ignored, that behind a technological development, there goes a lot of basic research, carried out over many many years.

It is also a fashionable thing in India to talk about the recovery of Japan from almost ground state after the second World War to one of the foremost industrially developed nations, and that India should follow the suit by persuing applied, rather than basic research. This, I think, is based on a rather superficial view of things. The initial recovery rate of Japan was not at all impressive, and the enhanced rate was not solely due to emphasis on applied research, but to a number of other factors, including political and trade interests of other nations. After achieving a somewhat comfortable position, Japan has undertaken extensive basic research and if today, anybody claims that basic research in Japan is at a lower key as compared to some of the Western countries, he will simply be not stating a fact Japanese contributions to science and technology are so important today that a number of publishing house in the West are translating Japanese journals, sometimes cover-to-cover for circulation in the English speaking world. Although the subscription rate for each of these journals is at least four times that of a comparable American journal, these publishers are doing booming business. This only demonstrates the high quality of basic research Japan is carrying out.

The point I wish to emphasize is that for India, there is no 'quickie' or short cut for reducing the scientific and technological gap with other advanced countries. What we can do perhaps is to start from what is available in the open literature and continue basic as well as applied research side by side. Any undue

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emphasis on either is likely to lead to undesirable results. A balanced approach is necessary; what is the optimum is perhaps difficult to determine, but if the research agencies keep an open mind towards both basic and applied research, and if they, after a very careful assessment of the soundness of a research proposal, support it, irrespective of whether it is of basic or applied nature, we shall be making a good start.

Basic Research Should Have a Motivation

While I strongly advocate the cause of basic research. I am also aware that the large volume of so-called basic research in India as well as in some other parts of the globe is unmotivated, repetitive and routine. Any basic research must have a link with the real world i.e. it must have a motivation for potential use. By use, I don't necessarily mean practical utility; use could, for example, be in explaining a certain observed phenomenon. A good theory to explain the peculiarities of jump phenomenon in some practical nonlinear circuits is basic research. But someone trying to interconnect nonlinear devices in various ways and to analyze them for possible jump phenomenon is doing unmotivated work. Not that such efforts may not lead to something useful but the result to effort ratio is likely to be infinitesimally small, and above all, this is far from being a scientific method. As another illustration, suppose a worker measures the dimensions of dew drops, in-situ, to an unbelievable accuracy; naturally, he needs a lot of refinement and innovations in the measuring equipments. 'So what'?One asks. If this measurement is not relevant in some context what use is it and why should it be called research ?

Repetitive research is a common phenomenon in many well established research groups in universities and other organizations. This, too, is a manifestation of unmotivated research. Some' Professor, working with his students, establishes a facility for some sophisticated measurements on some specific materials of practical importance, with generous grants from one or more agencies. After the initial aim is fulfilled, the facility continues to be used for generations for measurements on all kinds of variations of the basic material, resulting in a large number of Ph.D. these, and a much larger number of research papers. The later work is routine and does not involve much of thinking or innovations- it just requires hard labour. Spectroscopy, for example, enjoyed this state of affairs for a long time in India.

Applied Research Should Have a Basic Component

In the field of applied research also the situation is confusing and hence exploited for misuse of funds.

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In popular terms, applied research seems to convey the idea of an effort which should culminate in a piece of useful equipment or a gadget. Some people also appear to identify any experimental work as applied research. In the name of applied research, there are many groups who copy a standard design of an equipment, with some indigenization, and make tall claims of saving India's valuable foreign exchange. Equipment design and development, unless it has an innovative component, is not research.

Applied research, to my mind, is that effort which aims at applying results of basic research to a certain practical problem. In fact, the line of demarkation between basic and applied research sometimes is very thin. A good research has to do a combination of both. Basic research, unless it can be applied, tends to be unmotivated, while applied research, without a basic component in it, tends to boil down to copying a standard design. Suppose one comes out with a new design of a solar cooker, which is significantly more efficient than available designs and yet less costly. In the process, the designer has to solve the problem of more efficient energy collection, and less heat losses, by some innovative technique. He has to understand heat transfer phenomenon well and to apply the available results to be able to arrive at an optimum design in a scientific manner. I would call this a piece of good applied research; if standard basic research results are not available to the configuration he has invented upon, he might have to handle the heat transfer problem afresh. Thus he has to do a bit of basic research himself.

Assessment of Proposals and Evaluation of Achievements

Being associated with some sponsored research projects, I have some direct experiences of how research projects are evaluated. Many pieces of indirect information about evaluation have also come to my knowledge from friends in other organizations. The usual experience is that except one or two, majority of the members of the evaluation committee do not have more than a casual acquaintance with the subject area of the project. As a result, they get stuck on minor points and trivialities and the major achievements are not appreciated. The attitude of those members who are slightly more knowledgable sometimes leaves much to be desired. Many evaluators have the only objective of finding fault, wherever they can, with the project, and if they cannot do so, end up in making wild suggestion as to how the project should proceed in the future. Sometimes, this is in wide variance with the original aims of the project. Worse still, the team which evaluates

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the project later may have a different composition and the drama is then repeated.

The story on research project proposal assessment is no better. It is usually done by one or more referees. In principle, this is in order, but in the Indian context, the assessment is often influenced by personal bias of the assessor towards the proposer or his research. Since the number of active researchers in a given field is not too many, often the funding agencies call upon the expertise of once-active-now-passive type of referees. Many of them are outdated because they are not conversant with modern developments and therefore try to impose their own outdated ideas. The situation is worse if the proposer and the assessor are not active workers and belong to two different 'mutual support' societies. Yes, such societies do exist, although unregistered and vehemently denied in public, in which the members support each other's proposal following the 'live and let live' principle.

I strongly recommend that the research funding organizations like the UGC, DST, DOE etc. should get together and evolve a mechanism for more objective assessment of research proposals and evaluation of completed research projects. It should be ensured that the members of such committees are well reputed scientists, whose credentials are beyond question. If necessary, we should seek the opinion of well known experts from outside the country. There is, I believe, no dearth of funds, as far as scientific research is concerned; it is only the problem of a proper utilisation that India has to solve.

Basic Research in Industry

Many of the fundamental scientific results of importance have emerged from industrial research laboratories in the West. An example in point is the transistor, which has revolutionized the whole field of electronics. This device was born through the team effort of group of scientists bearing loyalty to various diverse disciplines like physics, electrical engineering and metallurgy at the Bell Labs, USA. The most recent solid state device, viz, the charge coupled device, also originated at the Bell Labs in 1970, while its elder sister viz , the bucket brigade device was conceived a couple of years earlier at the Philips Research Lbs, in the Netherlands. While these are examples of discoveries which are of direct interest to the concerned industry, there is a lot of theoretical and fundamental research which is carried out in the Western industrial laboratories. Filter theory and design, for example, was developed to great academic depths and much beyond

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Practical utility at that time, at Siemens Co. in Germany, [illegible] Co. in U.K. and Douglas Aircraft Co. in the United States.

I met a pure mathematician at the Post office Research Centre, Dollis Hill, London, who was deeply involved in the problem of sensitivity in networks. This investigation was not foreseen to be of any use to the British Post Office directly in the near future. I know a few very smart network theorists in the MBLE research labs of Philips at Belgium who have made outstanding contributions in network theory.

Research laboratories in Indian Industries are virtually unknown. What exists in an handful of industries can be more appropriately called problem solving set-ups, geared to the specific problems arising in those industries. The picture is very dismal, particularly in the case of Electronics industries. There is some enthusiasm, in the recent past, in public sector electronics industries in India; to set up development teams for prototype products, which are in routine production in advanced countries. In the private sector, the emphasis appears to be more on copying, and hence quick returns in terms of money. Because of lack of sufficient competition and hence quality control, anything useful made is sold. There is therefore no incentive for industries to spend money on the so-called basic research, which most industries consider as academic and therefore 'worthless'.

The textile industries, I am told, are an exception and I am glad it is so. Perhaps we should take a lesson from them, and start a few basic research organization, sely funded and managed by the industries in every subject of technological importance.

The collaboration between academics and industry has not materialised, even though we talk a lot about it, mainly because of the lack of a research component in the industries. What is the incentive of a professor in a University to spend some time in a production factory? Similarly, what can a senior engineer in a production factory contribute to an academic environment? The exchange between academics and industry would be meaningful only when the two sides can converse on some common wavelength and this link, I strongly believe, is research and that too, basic rather than applied research.

Concluding Comments

Despite the dismal picture I have portrayed about scientific research in general and basic research in particular in India, I am quite optimistic that if appropriate corrective steps are taken, the picture will

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gradually change to a brighter one. Even creating an awareness that all is not well with basic research in the country will be a positive contribution in this direction. The scientific community has a great role to play in this task, mainly in the form of self disciplining, in order to avoid falling into the kinds of traps I have discussed, which will lead to avoiding wastage of national resources. With such scientific culture, yet to develop in India, and with the gradual permeation of basic research in industry, I am sure things would gradually improve.

(Science & Culture, 50 , 1 (Jan.,1984) pp 6-9)

CHINA'S STRATEGY FOR ITS TECHNOLOGICAL TRANSFORMATION

by Surendra J. Patel

By its very size, China is an important member of the world community. It occupies a special place in the third world. Its development has continued to attract attention both from its ardent admirers and hostile critics. Any new policy in that country therefore merits serious attention. At a recent Conference on Science and Technology Policy and Research Management, held in Beijing from October 4 to 8. 1983, China's past policy in the areas of science and technology were broadly reviewed and several new departures were outlined. It was particularly noticeable that while the phrase science and technology continued to be used, the accent through all the papers presented by the Chinese participants was on technology. Zhu Rongji, Vice Minister of the State Economic Commission, presented a key paper: "On the Importation of Technology- Our Experience and Policy".

This note reviews the main phases in the past policy and the directions for the future against the background of a brief description of some of the basic indicators of economic and social development in China.

Current Economic and Social Setting

Much has been made about the changing estimates of China's national income. The difference in the public statements over the last few years on its per capita income ranges from 20 to 30 per cent. It is impossible to use them as a measure even for growth over time. Apart from the effect of fluctuating exchange rates on presentation of national income of any country in US dollars, it is now widely recognised that several conceptual and statistical reasons limit the value of such estimates for comparison among countries. They are in fact wholly useless when such comparison is among countries with vastly varying basket of output, prices, incomes and the role of the market and the state.

It would seem more meaningful to examine the way in which China's technological development has affected productivity and output in three broad fields keeping in the background parallel data for India: (a) areas covering the supply of basic economic and social needs of the population; (b) the development of industrial raw-materials; and (c) superpower technologies. Each of these are briefly described below to serve as a background to the new policies.

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(a) Basic Economic and Social Indicators

The arable area per person in China is much lower than in India. And yet, Chinese agricultural technology has helped provide its population with a much larger supply of calories per capita. Their grain output is nearly twice ours. Their health and nutritional levels are much higher. Visual evidence of malnutrition, impossible to escape in India, is not easy to locate in China.

Life expectancy in China is 64 years against India's 51. Adult literacy at 66 per cent of the population is higher than only 36 per cent in India. Impressive indeed is the enrolment in primary education, covering 93 per cent of the age group; the comparable coverage in India is 64 per cent. The difference is even greater when it comes to secondary education where more than half the relevant age-group is enroled in China with the proportion in India amounting to under 30 per cent. There are two aspects which may be singled out here: (1) China now gives all its education to all its people in one single unified script, with minor variations in accent and pronunciation. We are all too familiar with the sharp linguistic contrasts in India (2) The enrolment ratio for female students is much larger and the drop-out rate much lower than in India. It is, however, at the third level of education that India enjoys considerable superiority over China. The decade-long Cultural Revolution when the current dogma was 'better red than expert's decimated its intellectual and technological skill development. Even in the production of industrial items of mass consumption, such as bicycles and radios, the Chinese output is 3 and 15 times respectively higher than in India.

(b) Growth of Industrial Hardware

The common use of index numbers for industrial production often gives a misleading picture of growth rates, particularly because of the differences in the weights of various sectors and their growth over time. For this reason, attention may be focused on four key items, which serve as strategic industrial inputs throughout the system of production: for example, steel, cement, fertilisers and the energy group.

China produces some 38 million tonnes of steel, 80 million tonnes of cement and 12 million tonnes of fertilisers—each of them 4 times as high as in India. As far as the energy group is concerned, China's production of over 600 million tonnes of coal is 5½ times that of India; of crude oil at nearly 110 million tonnes nearly 4 times India's; and the generation of electricity at 300 billion Kwh is 3 times India's output.

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This note is not meant to present a picture of comparative development of India and China. But India's national pride does not have to be too sensitive to overlook or ignore what a long distance China has travelled ahead of it in terms of the production of these basic industrial items. Nor would it serve much useful purpose to ignore this advance by questioning the validity of the data, or the quality of the products in China.

(c) Superpower Technology

While neither China nor India considers itself superpower, there is little doubt that, as the two countries with the largest populations in the world, they both continue their technological advances in areas which are attributes of superpower status: for instance, nuclear research and development of atomic and hydrogen power space research, including development of spacecraft and satellites. These are areas which have both military and civilian civilian significance. The least one can say in that in these fields too China is not lagging behind India.

This brief review of the current economic and social setting underscores the significant strides forward taken by China in technologies required for meeting the basic needs of its people, creating a powerful industrial base, and laying the foundations of a superpower status. It would seem as if it has been walking well on all these three legs.

In the thirty years since the establishment of the People's Republic of China, it has faced immense turbulence and upheavals: for example, the destructive civil war, the Korean conflict, the break with the Soviet Union, the Great Leap, the Cultural Revolution, the four modernisations, not to mention the disputed great famine in the early 60s. Despite all these, China has emerged as a country with significant strength in its technological base. It is now set for its transformation. Before we come to its new policy, it may be useful to look quickly at the main phases through which its technology policy has passed over the last 30 years.

Main Phases in Evolution of Chinese Technology Policy

Two broad phases may be distinguished: the period from early 1950s to 1978 and the period from 1978 onwards.

In the first phase, covering nearly 30 years, China bought complete plants from abroad. During these three decades there were, however, changes in the emphasis or concentration on certain industrial items. The 1950s, for example, were marked by the establishment of the capital goods industry supplying China-made equipment

for mining energy, transport,industrial raw materials, textile and light industries. During the 1960s China's import of complete sets of equipment concentrated upon petrochemicals, synthetic fibres, and processes for various varieties of steel. The 1970s witnessed a concentration on nitrogenous fertilisers, chemical fibres, integrated coal mining equipment and steel rolling mills.

To a large extent, the first phase was dominated by setting up new industries with relatively little attention devoted to the technological improvement of the existing enterprises. As the Chinese Vice Minister of the State Economic Commission. Zhu Rongji stated: "After turning out its first generation of products for example China's machine-building industry did not continue to consolidate itself technically through research and development or the import of newer foreign technologies. Many of its products remained unchanged for decades. The same was true more or less for other industries. That is why they lagged far behind the advanced countries in some areas".

The second phase opens in 1978 following an intense examination of the past policies. It marks "an open-to-the-outside-world economic policy"as its main plank. It marks a decisive shift from the import of complete plants to import of technologies for the transformation of existing enterprises. In the past, China signed only a few dozen contracts each year with foreign countries for the import of technologies. The number of such contracts increased to some 100 in 1982 and is expected to reach several hundreds in 1983.

Two important decisions have been made: one, formulating a detailed programme to import 3000 items of advanced technology in the last three years of the Sixth Five Year Plan (1981-1985) and thereby to speed up the technological transformation of existing enterprises, especially the small and the medium sized ones; and second, changing the system of management of imported technology through greater decentralisation in decision-making to bring about transformation of imported technologies. For instance, two of the most important industries areas of China, Shanghai and Tianjin, are now given greater power to experiment with such transformation.

Major Elements in China's Strategy for its Future Technological Transformation

China has set itself ambitious targets for the next 20 years. Its perspective plan lays down the strategic

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Target of increasing four-fold its annual industrial and agricultural output by the end of the century. This would require a combined output growth of 7 per cent per year. With the fall in its population growth rate to only 1.2 per cent per year, these targets imply an annual expansion of percapita output by 5.8 per cent per year- a formidable goal indeed. It would raise China's per capita output more than three-fold in 20 years.

Zhu Rongji, Vice Minister of the State Economic Commission, set out eight main elements in China's policy concerning the import of technology. The first three elements of this 8-point package concern the content of the technology imports, the fourth and fifth relate to the management of this policy; and the last three- points -6,7, and 8- cover several other aspects.

(a) Content of Technology Import Policy

(1) The imports of technology is to be geared to the needs of technological transformation of China. It is to be conducted step by step "in a planned way in accordance with the priority areas of the country's development programmes" It is to proceed under the guidance of a plan which matches the requirements of Chinese technological transformation. During the sixth five year plan the concentration will be on the machine building and electronics industries.

(2) The emphasis will shift to importing technology rather than complete plants as in the last 30 years. It will be on buying 'software', including new production techniques and processes, patented or unpatented technologies, knowhow and techniques for manufacturing the key equipment and instruments necessary for the operation of the imported technologies. Consultancy and other services needed for training the workers and skilled manpower will also be included in this. This does not of course mean that the policy of importing complete plants will be altogether abandoned. Advanced technologies embodied in nuclear power plants, large scale opencast mines, integrated circuits, etc, for which China is at present unable to supply domestically technologies to meet needed quality requirements, would continue to be imported.

(3) As far as the choice of imported technology is concerned, the emphasis will be on "advanced, yet applicable technologies". China will not be importing blindly the most advanced technologies "which are in any case hard to get, more expensive and difficult to master". The main thrust would be to improve what exists, modify what is imported, and to master and assimilate the new technologies.

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(b) Management of Technology Policy

Two important innovation have been introduced in the management of technology policy.

(4) There will be a greater emphasis on decentralising power to local levels, while at the same time maintaining effective co-ordination and management. In the technology import plans, certain powers will be delegated to the departments and local authorities, which will be given the responsibility of deciding on the items to be imported, and of approving to be imported, and of approving the feasibility reports. The two main industrial areas, Shanghai and Tianjin, are given special authority to experiment with several approaches. The importing units will be able to organise joint teams, involving foreign trade companies and advisory organisations to take charge of all the work involved in import of technology. This would range from consultation with enterprises, analysis of problems and feasibility studies, to technical and trade negotiations. The State Economic Commission will however continue to co-ordinate the work of different departments and areas with a view to preventing wasteful or repetitive technology imports.

Several flexible and diversified ways would be adopted in importing technology. These will vary according to different conditions and will take into account the preferences of the transfers of technology. The choice will include production under licence or other co-operative arrangements and import of individual production units. For some uptodate technologies, joint ventures may be set up, emphasis being placed upon improving technological efficiency through supply of consultation services. Several incentives are being offered and more are under consideration. This include reduction or remission in customs duties and taxes, including income tax on joint ventures, selling products of joint ventures in the Chinese market and allowing such joint ventures to pay in Chinese currencies for inputs bought in China. The joint ventures will also be granted greater power of decision in financial and personnel affairs, planning, purchasing and selling.

(c) Other Elements

(6) Efforts will be made to step up exchange of technological information.

(7) A draft "patent law of the People's Republic of China", now under consideration, will be promulgated as soon as the draft has been fully considered. Similarly, a draft law on technology transfer is also under consideration for future adoption.

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(8) There will be much greater emphasis on co-operation with friendly foreign countries. Such co-operation upto now has been mainly with big companies. In future, emphasis will also be given to develop technical co-operation with small and medium size foreign enterprises.

Some Observations

Quite clearly China is undertaking a major departure in the policies pursued in the last 30 years. Having built a powerful industrial base under centrally planned public control, it is now opening itself to draw maximum benefits from technological advances achieved in the world outside. The key elements in this departure will be a long-term strategy for its technical transformation, which would involve moving away from imports of turnkey plants to imports of technology, and to the imports substitution of technology itself. If will involve much greater decentralisation in decision-making with co-ordination remaining the central concern and introducing several innovations in the transitional period. The assessment of its full implications will require time to test the results.

There is a certain resemblance in China's new strategy with the main features of the policy pursued by Japan during the 1950s-a policy which relied on importing advanced technologies from abroad with maximum attention devoted to incorporating them into the production system and mastering the very process of technological adaptation, modification and innovation, without at the same time permitting the external enterprises to obtain control over national firms either through equity or through restrictions imposed upon the use of imported technology.

(Economic and Political Weekly (March 3, 1984,) pp373-75)

SECOND LUNAR METEORITE IDENTIFIED

By Richard A. Kerr

Japanese researchers have announced that a search of their collection of meteorites found in Antarctica has uncovered a rock that must have been blasted off the face of the moon. It is only the second such lunar meteorite ever found and offers the possibility that a second new site on the moon never visited by man or machine has been sampled.

The analyses in hand, although few in number, seem convincing. Keizo Yanai and Hideyasu Kojima of the National Institute of Polar Research in Tokyo presented their mineralogical and chemical evidence for another lunar meteorite last month at the Ninth Symposium on Antarctic Meteorites, held in Tokyo 22 to 24 March. When the 25 gram, dusty-gray meteorite designated Yamato 791197 was cut into thin, translucent sections, small fragments or clasts of lighter minerals stood out against a dark brown back-ground. The larger clasts contained mostly the mineral plagioclase and minor amounts of pyroxene and olivine. The smaller clasts were individual mineral fragments. Most of the clasts showed signs of having been shocked as by an impact. The Japanese researchers also found a few small glass spherules.

This appearance alone was enough to convince two Americans who were given an opportunity to inspect a thin section of the meteorite. Jeffrey Taylor and Klaus Keil of the University of New Mexico, who have worked extensively with both meteorites and Apollo moon rocks, could see immediately that this meteorite closely resembled rocks from the lunar highlands called regolith breccias, rocks formed from lunar soil and rock fragments under the pressure of a meteorite impact.

The evidence goes beyond the meteorite's appearance. Yanai and Hideyasu found that the ratio of manganese to iron in pyroxene and olivine minerals of their Yamato meteorite is about half that of the most similar type of meteorite but about the same as that of lunar rocks. In addition, Robert Clayton of the University of Chicago has determined the oxygen isotope composition of a sample supplied by the Japanese researchers. The meteorite value is "bang on the lunar value. There's not much data in yet, but it's all consistent. I'm convinced," says Clayton. He and others have not waited for the extensive analyses

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accorded the American find of last year (Science, 15 April, 1983, p. 288) because [illegible] by themselves form a strong argument for a lunar origin. Only one class of meteorites has an oxygen isotope composition that is close to the lunar composition, but the mineralogy of these meteorites is entirely different from that of lunar rocks and the Yamato meteorite.

Perhaps the most exciting possibility is that the new discovery is the product of a second impact at a different site on the moon from the first. Lunar specialists were pleased to find chemical indications that the lunar meteorite in the U.S. Antarctic collection is not from the vicinity of the sampling by Apollo astronauts or Soviet Landers. A second impact site, possibly from near the visible edge or even the far side of the moon, would be a real find.

Researchers are anxious that any new lunar meteorites be opened to the kind of consortium study that quickly produced such a variety of analyses of the first specimen. Since the ultimate number of lunar meteorites may not exceed two or three in the present combined Antarctic collections of more than 6000, the need for close cooperation is obvious.

(Science, 224, 4646 (April 20, 1984) p. 274)

JAPAN-ASEAN MINISTERIAL MEETING OF SCIENCE & TECHNOLOGY

Expanded Cooperation Activities Reaffirmed

by Akira Oikawa

The Japan-ASEAN Ministerial Meeting on Science and Technology was held in Tokyo at the Ministry of Foreign Affairs on December 1-2, 1983. The initiative for the meeting had come from Prime Minister Yasuhiro Nakasone during his visit to the ASEAN countries last May, as part of his intention to promote greater cooperation between ASEAN and Japan in science and technology. The ASEAN governments received Nakasone's proposal with great appreciation.

The Japanese government was represented at the conference by Shintaro Abe, Minister of Foreign Affairs and Takaaki Yasuta, Minister of State for Science and Technology. The ASEAN countries were represented by Dr. B.J. Habibie Minister of State for Research and Technology (Indonesia) and Chairman of the ASEAN Ministers of Science and Technology Conference; Datuk Amar Stephen Yong, Minister of Science, Technology and the Environment (Malaysia): Dr. Emil Q. Javier, Minister of the Philippine National Science and Technology Authority: Dr. Wong Kwei Cheong, Minister of State for Trade and Industry (Singapore), Sidek Saniff, Parliamentary Secretary for Trade and Industry (Singapore); Damrong Lathapipat, Minister of Science, Technology and Energy (Thailand); and Prapas Limpabandhu, Deputy Minister of Foreign Affairs (Thailand). Awang Zakaria bin Dato Haji Noordin, Deputy Director of Public Works (Brunei) also participated in the meeting. The Secretary-General of the ASEAN Secretariat and the Chairman of the ASEAN Committee on Science and Technology, as well as other senior government officials from the participating countries, also attended.

Prime Minister Nakasone gave a welcoming speech at the opening session of the meeting Habibie, on behalf of all of the ASEAN nations, and Abe also addressed the session. Yasuta and Habibie were appointed respectively Chairman and Co-Chairman of the meeting.

At this meeting, the Japanese and ASEAN ministers succeeded in holding wide-ranging discussions on such topics as specific policies and measures to encourage international cooperation in science and technology. The ministers all agreed that the meeting, the first of its kind to be held, provided a highly useful forum for discussing future prospects for cooperation in the field

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of science and technology between Japan and the ASEAN countries. Noting with much satisfaction the fruitful and active collaborative efforts undertaken so far in this field, the ministers expressed confidence that such activities would create a sound foundation for cooperation in the future.

The ministers also agreed that future projects should be directed toward meeting the needs of the ASEAN nations, and be of mutual interest and benefit to both the ASEAN countries and Japan. Consequently, they stressed the importance of carrying out an effective sharing of responsibilities in advancing international cooperation in order to maximize the utilization of available capital and human resources.

This ministers emphasized the desirability of an early follow-up to the meeting so that detailed, specific projects could be formulated for future implementation. With this in mind, they recommended that a meeting of senior government officials from all of the countries concerned be convened during 1984 at a time to be agreed upon. The ministers themselves also resolved to meet again for the purpose of continuing their dialogue on a regular basis.

The two-day meeting ended with closing speeches by Yasuta and Yong.

Although the Tokyo conference proved to be an important starting point for cooperation between Japan and the ASEAN countries in science and technology, it is important that dialogue in this field be continued by both sides for the advancement of international co-operation for the future. For this end, the meeting of senior government officials that is expected to occur next year is seen as being crucial for formulating specific ways to promote greater collaboration in science and technology.

Japan has been making vigorous efforts to extend cooperation in science and technology to the developing nations under the various programs and organizations described below. In future discussions, there will most likely be greater debate on how to utilize Japan's existing system for scientific and technological collaboration between Japan and the ASEAN countries.

1. The Japan International Cooperation Agency (JICA)

JICA is the only agency in the Japanese government whose main purpose is to extend various forms of technical cooperation to the developing countries, on the basis of established intergovernmental agreements. JICA engages in

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a wide variety of cooperation activities, including the acceptance of foreign technical trainees, dispatch of experts, provision of equipment and implementation of technical cooperation projects. Over one-third of JICA's funds, or about $100 million, is disbursed annually to the ASEAN region. Through the activities of JICA, Japanese researchers are recently making greater and more effective efforts in international cooperation by working with native experts in developing technologies that are suitable for the recipient countries.

2. Institute for Transfer of Industrial Technology (ITIT) Program

The ITIT program is directed toward the improvement of existing technologies and development of new technologies appropriate to the regional conditions of the ASEAN nations and other developing countries through joint research carried out by MITI's Agency of Industrial Science & Technology.

MITI provides R & D subsidies to the private sector for establishing demonstration plants and implementing joint operations in the developing nations. Although projects in basic research under the ITTT program were recently terminated, MITI established the Research and Development Cooperation Program in April 1983 to handle the organization of pilot plants and private-sector collaborative research in response to the high-level needs and numerous R & D requirements of the developing countries.

3. The Tropical Agricultural Research Center (TARC)

A research agency affiliated with the Ministry of Agriculture, Forestry and Fisheries, TARC is primarily engaged in conducting joint research with research institutes in the developing countries on the basis of already established agreements. The means of cooperation carried by TARC include the dispatch both long and short term of Japanese researchers abroad, acceptance of overseas counterpart researchers and organization of international symposia in Japan. These efforts result in benefits for all parties concerned. Japan is able to expand its sphere of research, while the developing nations are able to realize the advancement of their own R & D potentials.

4. Scientific Exchange Under the Core University System

In order to encourage greater scientific exchange with the developing countries, the core university system designates in each priority research field certain universities in Japan and its partner countries to act as centers for scientific exchange within a wider network

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of universities. The types of activities conducted under this system include the exchange of researchers, carrying out of joint research and holding of seminars.

At present, the core university system covers only Indonesia, Singapore, Thailand and the Philippines. Preparations for an exchange with Malaysia are now being carried out.

5. Special Coordination Funds for Promoting Science and Technology

With the cooperation of the numerous research institutes in the Japanese government, this program is directed toward promoting the development of frontier and basic research for the purpose of advancing domestic collaborative research. Yet this special program also facilitates cooperation in the international realm by sponsoring activities with overseas research institutes on the basis of the principles of equity and reciprocity.

The history of Japanese cooperation in science and technology with the developing countries is still relatively short; most of the programs described above, for example, were established only from 1970's. Yet Japan's initiative to hold the first Japan-ASEAN Ministerial Meeting on Science and Technology may be seen as evidence of a maturation of Japanese policies for international cooperation as a demonstration of Japan's willingness to take an active role in formulating means to enhance the overall welfare of mankind.

(Look Japan, 29, 335 (Feb.10, 1984) p.18)

ETHICAL CONSEQUENCES OF TECHNOLOGICAL CHANGE

By M.K. Rajakumar

It gives me a great deal of pleasure to be honoured by the President and Council of the Singapore Medical Association by the invitation to deliver the Annual SMA Lecture. It is for me a homecoming as I am back in the city where I studied and graduated, among my friends and teachers. Presidents of both our national medical associations, which would be one but for an accident of history, have even until now shared this common background. In both the twin cities of Singapore and Kuala Lumpur, several generations of professional men and women share common memories and have strong ties of friendship between them. It must indeed be this special regard we have for each other that persuaded the Singapore Medical Association to go outside this island of such numerous talents to invite a man of my humble capacities to speak on a subject as important as Ethics.

A great many kind things are said on such occasions and your distinguished President and my old freind has been lavish in his remarks. I must go beyond the customary disclaimers to say that there is so much I wish I had done, so much I wish I had done better, and more I wish I had the capacity to do. I am clearly a case of aspirations overvaulting capacities and no one is more conscious of this than I am.

More still when I look at the distinguished line of speakers that have preceeded me, many of whom were my teachers, all of whom I would consider it a privilege to listen to any day.

We are unique as a profession in that we alone are ethically commanded to protect, maintain and sustain human life and [illegible] to cure to [illegible] pains. Because of our responsibility for life, at birth and at death, it is necessary to remind physicians that they must not play God with the lives of the men, Women and children in their care.

Dr. Rajakumar, President of the Malaysian Academy of Sciences, Malaysia delivered this lecture at the SMA National Medical Convention on 16-4-1983

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We live in times of great and rapid change. These changes have already had profound effects on the way we live and the way we think. We have shown a remarkable capacity to assimilate into our lives the uses of new technologies. What has been dismaying has been mankind's inability to develop the spiritual values and moral judgement to put technology to its proper uses. The spectacle of the first nuclear explosion brought to Robert Oppenheimer's mind the words of the Bhagavad Gita. I am come as the Destroyer of Worlds". We still live under the shadow of that mushroom cloud and I am amongst those physicians who take seriously the prospect of nuclear conflict that would disrupt civilized existence as we know it. Although less spectacular, the advances in medical technology have transformed dramatically the scale and scope of medical interventions and have placed stresses on our concepts of ethics that stretch them to breaking point. I welcome opportunities such as these to share my fear that we rush like the Gadarene swine down the technological slope to our own destruction.

We sometimes lose sight of the truth that the practice of medicine has been technologically determined to a very great extent. Where would the practice of surgery be without the discovery of asepsis and anaesthesia, or internal medicine without the discovery of the circulation of blood. Untill this century our pharmacopoea differed little from that of traditional medicine as we know it today. Only the drugs, opium, digitalis and aspirin remain of that vast compendium.

Even as technology has changed the way we practise, our ethical concepts have come under pressure to change in response to what is seen as the needs of the times. Medical schools with overloaded technical curricula can find little time for ethics. All sorts of medical schools produce all types of graduates and sometimes they are ethically blind, aware only of the status of the physician and not of the weight of moral responsibility that comes with it. Each year when I lecture to students on ethics. I commence with the complaint that ethics should not be taught in this way but in relation to their patient by every single teacher in the faculty. I find these young people extremely concerned about ethical issues and more than a little confused with the reality that they are already beginning to comprehend. There is a conflict in their value system.

In this part of the world, we are inheritors of ancient cultures, Chinese, Indian and Malay and our traditional values still dominate our private lives and dictate the pattern of our behaviour and our responses to events. yet our professional lives are insulated from these

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traditional values; in our professional behaviour we are the distant inheritors of the Protestant-Puritan ethic and of the Hippocratic tradition. There is this schizophrenic quality to our educated elite that I will not explore further on this occasion.

We know little of the historical Hippocrates but the ideal of the good physician in the Oath is over 2,000 years old and was adopted by Christian Europe and Muslim Arabs.

You are all familiar with the Oath although few physicians take it and, no doubt fewer still measure their professional lives against it.

The heart of the Hippocratic Oath is the injunction not to do harm, never to take human life, to keep confidences and to give equal consideration to people whatever their status.

These are ancient injunctions and are contained in ethical rules of physicians in all our cultures. How have these honoured injunctions withstood the test of time in the face of technological change.

To take one example, among the more important of these technological advances is the computer which can provide links between medical records and other data banks such as school records, police records, employment records. The individual's medical records are no longer maintained by a specific physician but owned and in the custody of institutions and access to them is beyond the control of the physician. The patient himself is often not directly in relation to the physician but to the organisation that employs the physician. These are all very important issues but my remarks today will be directed to the problems of ethics at the extremities of life, from the ethical consequences of termination of foetal life to the maintenance of terminal life.

Abortion has been legalised in many countries. It is sometimes forgotten that the impulse for the legalisation of abortion has come not from the medical profession but from the changing status of women and the grim hazards of illegal abortions. I would go further and say that if abortions were made illegal or if the laws against abortion were enforced where it is still illegal, I do not believe that the number of women seeking abortion would decrease but a vast illegal abortion industry would spring up and only the poorest would be condemned to suffering and death in the hands of unskilled operators. I

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shall not go into the profoundly important subject of the morality of abortion. My concern today is the consequences that arise from the changes in our norms of ethically acceptable behaviour with regards to the embryo.

Contraceptive technology has advanced very rapidly in the past few years. It is likely that in many societies, more births are prevented than permitted and there are countries that report more recorded abortions than births. The community as a whole and physicians in general have come to accept this with equanimity because it is argued as socially necessary in the face of pressures of population growth.

It is possible now to poison spermatozoa with a variety of drugs, or with hormones suppress the release of the ovum and make the endometrium inhospitable. By adding a little copper you can induce the endometrium to shed an implanted zygote. A few millimeters pressure of suction can extract endometrium and zygote even before a preganancy can be diagnosed. You can operate or you can stimulate the uterus to contract and expel the foetus prematurely. It is likely that drugs will become available in the near future from the dispensing machine that will safely inactivate the sperm in the male, or induce a monthly abortion in the female. That's technology for you.

As a result of social pressures, abortion is legal and ethical codes have been changed to accept abortion and to exclude the pre-viable embryo from the protection of the injunction not to kill.

The question now arises of the status of the aborted embryo. Can the pre-viable embryo be used for experimental purposes. Can it be cannabilised for parts or used as an experimental subject. The embryo is not a legal person under the law; the ethical code has permitted its destruction. Is there now any restriction to what uses it can be put.

As you all know, foetal material can be obtained at an even earlier stage. For many years it has been shown in animals that oocytes could be extracted from the ovary and fertilised in vitro and reimplanted into the womb. Between 1970 and 1974, when Edwards raised the possibility of this in human beings, there were few who regarded it a serious possibility. Within a few years, it was an accomplished fact. You can now learn the technique in a fortnight and the numbers of centres and research workers able to do this multiplies each year. Multiple oocytes are withdrawn from the ovary and individually fertilized. A few are introduced

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into the womb and the rest are available for study of embryonic growth and for experimentation. What ethical restrictions are there on the use of these human zygotes?

Genetic material has become a valuable natural resource with the emergence of recombinant technology. It has become possible to introduce genes carrying specific enzymes, or associated with certain traits, into other living creatures. The first attempt with human beings have already been made. How do you monitor and control these experiments without retarding the acquirement of valuable, indeed essential, knowledge. How far do you go? How should we react to the possibility of para-human primates being grown in experimental farms as a result of recombinant technology, in vitro fertilisation and reimplantation. If cloning becomes possible then there is the danger of cloned humanoids grown in surrogate uteri kept as 'the imbecile in the backroom', available for the cannibalising of parts for the wealthy and powerful who do not want to die. If controls in the developed countries prevent this sort of activity, will some developing country be used for such profitable but morally abhorrent genetic farming?

In the case of in-vitro fertilisation and transplant, if the ovum and sperm come from husband and wife, no moral or ethical issues arise. If in addition to blocked tubes the uterus is also unhealthy, then a surrogate mother can legally be used in the United States. The surrogate mother must be emotionally prepared and bound legally to relinquish the infant she has nutured to strangers whose genetic material she has carried. The problem has already arisen of an infant born deformed by AID to the surrogate mother which neither party wants.

A further step down the road is the establishment of commercial sperm banks. AID is used where the male alone is infertile and the impregnation of the women personally by a strage man is culturally and emotionally unacceptable. The physician acts as intermediary and undertakes the task of instrumentally placing the semen in juxtaposition to the cervical os. Sperm banks have been established in the United States and it is already becoming possible for a woman to specify the characteristics of the donor male whose sperms she will accommodate.

The antenatal diagnosis of foetal abnormality has become an important new indication for abortion. It will soon be possible to make the diagnosis much earlier by use of recombinant technology on chorionic villi. Trisomy of 21 and thalassemia are two important diagnosable conditions in our part of the world.(Ultrasound

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allows early diagnosis of spina bifida and termination is carried in many countries although it has been found that the image of the embryo on the real-time scanner is sufficient to bond the mother to the foetus and for her to refuse termination. The other major cause for termination is rubella infection. This involves the destruction of a significant number of normal foetuses, depending on the time of infection. Pre-natal sex determination is now possible and there are foetuses being aborted for belonging to the wrong sex.

The rule then is that once the defective foetus is born it is protected by the laws of the country and will be entitled to loving care, if diagnosed a few weeks before delivery it may be killed. Once born it can even sue for damages against persons who may be liable for having caused the deformity or for not having prevented it. Imaginative lawyers in the US have even suggested legal action by the deformed infant for 'wrongful life', i.e. for not having been killed and spared the misery of life.

The extent of this misery is variable. The Down's infant is generally a happy and contented person although it will have more than its share of complications. The spina bifida, say a meningomyelocele, is assured of a long miserable life which will tax the parents to the utmost. Where the infant is born with an additional defect that is incompatible with life, e.g. Down's Syndrome with duodenal atresia, then can the infant be allowed to die by withholding surgery? You may think so, but in the recent Arthur case in the UK, a Down's Syndrome infant developing signs of pneumonia on the second day was denied treatment and died. Dr. Arthur was saved from conviction only by the appearance of a pathologist who could find multiple congenital abnormalities that were incompatible with life.

The technology to sustain life has raised important issues at the other extremity of life. How far should we go to use our new machines to maintain life. The issue of sanctity of life is brought up with greater passion since the individual has developed a personality and a presence and has emotional and economic links in the community. No society accepts that human life is totally inviolate. Tribes and states since time immemorial have gone to war to kill members of other tribes or states that have annoyed them. Many states still break the necks of individuals who cause sufficiently big problems. Ironically those persons who favour abortion are usually opposed to capital punishment and vice versa although I believe there are countries that favour both.

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Some states make suicide illegal and if you fail in your attempt at suicide, you will be punished for your pains, but this is changing. It is illegal as well as unethical for a physician to assist in a suicide. Every physician knows the terminal case who begs for his life to be ended, more often I sense out of helplessness and hopelessness than out of pain. Where the patient is in pain, we have powerful drugs and techniques to relieve the pain, even if in the process life is shortened and consiousness impaired. Beyond that physicians may not ethically or legally go. If society wants to give individuals the right to kill themselves, then physicians will have the ethical obligation, not directly to help, but to continue caring. Direct involvement would introduce an ambivalence into the relations between the physician and patient and create new tensions that would destroy the heart of that relationship. Instead lay organisations have sprung up that provide advice on how to kill oneself and in Scotland you can buy a 'do-it-yourself' booklet.

In the United States, 'right-to-die' laws are being advocated and the physician, in determining the vigour of resuscitative efforts, is expected to be guided by the wishes of the individual expressed in 'living wills'. Hospitals have their own policy on resuscitation. An elderly physician wrote some years back, noting with bitterness, that he was not at the age where some London Hospitals would not resuscitate him if he had ventricular fibrillation. Yet another distinguished cardiologist died from a my-ocardial infarction because his physicians relunctantly respected his firm instructions not to be resuscitated, although he might had many years of useful life if he had. One wonders if he would have felt the same if he had been defibrillated and lived to recondider. Difficult though it is to talk about it, some patients should not be resuscitated but be permitted to die with dignity. We all must die one day, and as physicians we would choose a massive myocardial infarction before we become utterly senile; and we must live in terror that some enthusiastic intern with a defibrillator would shock our tired heart and revive our weary brain, not to give us a new lease of life but only to prolong our dying. Lay persons who are enthusiastic for the physician to undertake euthanasia are full of the good intentions with which is paved the road to hell. These good souls must be unaware of the complex emotions of guilt and recriminations that engulf physician and patient, family and friends around a death bed. The patient with the legal right to die may change his mind each day, indeed

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by the hour depending on the degree of pain and discomfort on mood and relations with those he or she loves. Granted the right to die, he will look guiltily at his physician each time he changed his mind and feel pressured by the long, long suffering faces of those who are to mourn his death.

The brain damaged patient is an entirely different issue. If the cerebal cortex is permanently damaged, and physicians are agreed that coma is irreversible, then extra-ordinary measures need not be taken to sustain life. This means in practice that mechanically assisted ventilation is not offered but once initiated, disconnection is a more difficult matter, In the case of Karen Ann Quinlan in the United States, the Court returned the decision to the physicians in consultation with the family, the ventilator was disconnected and the young women continued to breathe, still in coma.

The new concept of brain stem death, as defined in the UK, means that death has occured when there is permanent functional death of the brainstem. When the ventilator is disconnected, there will be no respiratory efforts and the heart will stop shortly. Even on the ventilator, dissolution of tissues will proceed and the heart will stop within a few hours to a few days. Once a diagnosis of brain stem death is made, if an organ is needed for transplant, the ventilator can be left on to sustain the heart until the required organ or organs are removed from a beating heart cadaver.

This concept has been cogently defended and the Conference of the Royal Colleges in the UK have clearly described how brain stem death can be established. The importance of this new definition of death lies in the need for organs for transplant that have suffered as little anoxia as possible. The logic is perfect but we must make allowance for the primitive reluctance to accept as dead a body with a beating heart.

Our techniques for life support are improving and most vital functions can be temporarily replaced. This is an expensive technology and in a society with limited resources - which is true of every society - that means life-support systems are either not available for everyone or else some other facility must be deprived of resources to provide more life support systems.

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In the poorer countries, the choice may be simple and scarcity will determine that only those clearly going to recover to near normal life with reasonable life expectancy will be given the use of expensive resources. There are countries where unfortunately the choice may be simpler still and the politically most influential and the wealthy will get priority every time.

Much of the decision-making on the allocation of health resources is out of professional hands. Politicians make these decisions, physicians live with them. We have the technology to immunise children against diptheria, tetanus, poliomyelitis, whooping cough, rubella, measles, tuberculosis, even hepatitis B, and perhaps, liver carcinoma. The technology has been available for a long time to ensure clean water and safe disposal of sewage, control of vectors and prevention of pollution. Physicians do not have the power to determine how available technology will be applied out we do have an ethical obligation to speak out about it.

However, the physician has wide discretion in the use of extraordinary medical life-saving therapy such as bypass operations, organ transplant, dialysis and the exhibition of expensive drugs, and normally exercises it without challenge. We are ethically bound to make our choice of patients to benefit from these technological developments on purely clinical grounds yet social criteria must inevitably creep in. In the UK, for example, it was found that medical indications for dialysis were unconciously adjusted by physicians to fit the number of places available. A majority of centres would regard with disfavour candidates above 60 years of age. When physicians in 25 renalunits were recently asked to evaluate 40 patients in renal failure with a view to selecting 10 for dialysis, it was found that only a third of the patients would have been accepted by all units and no patients were rejected by all units. This would suggest a considerable degree of subjective variation on what is purportedly an objective clinical decision. At Seattle, where they pioneered dialysis, a civilian board makes the choice with the help of specific criteria and the report on the deliberations of this Board makes depressing reading, inducing one to revert to the view that these decisions are perhaps best left to physicians. In Los Angeles, optimum candidates are identified, that is, with no other significant organ damage, and one is selected by lot to fill the vacancy in the dialysis pool.

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The physicians making these decisions or advising on them will in practice have a great say. It has been argued that physicians have no training in moral philosophy or ethical analysis, yet make what are essentially moral decisions in the guise of clinical judgement. Philosophers may go on principle, but physicians have to decide case by case. My fears go further. Do physicians in fact function as gatekeepers to scarce resources, watchdogs for the Treasury, so to speak. Does clinical judgement serve economic necessity and are physicians the instrument of politically determined rationing of scare resources. In private practice, those who cannot pay can either go to a state hospital or go home and die, you ration by ability to pay. Extraordinary life saving technology such as by-pass or dialysis are purchaseable. Where it is available, the family is under great emotional pressure to purchase it with whatever resources they have for the satisfaction of having done everything possible. Have you ever heaved a sign of relief when a patient in renal failure died before the family could sell every - thing they owned, and got in debt to purchase a few weeks of dialysis time? These human tragedies will increasingly press down on physicians as medical technology advances and more can be done. For example , when the problems of transplant rejection are solved, there will be an explosive increase in demand for kidney, liver, heart and other organ transplants; or for the machines that are invented to do the task. Has the physician the moral qualities and the ethical strength to make these choices, or even to advise on them and to quietly reject decisions that are contrary to his or her conscience and his or her ethical standards. Or will events make us the custodians of interests other than those of our patients.

We are not permitted as physicians, ethically and in good conscience, to distinguish between millionaire and indigent, prime minister and pauper, political prisoner and parliamentarian. Is this a sustainable position in any society? When it is breached, then where do we stop. If a tyrant needs a young heart to transplant, will there be physicians ready to oblige by diagnosing brain stem death in the prospective donor?

When the technology is primitive and unsafe, the pressures are small, but when the technology is perfected, great indeed will be the pressures to get to the head of the queue.

The dilemma of the profession is a universal one. More and more physicians depend for their living on the State or on great private institutions or boards. More and more physicians see their personal advance-

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ment in the role of technologists dependent on expensive equipment and highly trained staff. Physicians are not invariably men or women of special moral qualities or of a compelling sense of vocation. They are selected as young men and women essentially for their examination results, and may be motivated by the high status and large incomes that they believe is assured by a medical career. If at medical school they see that their contemporaries lack ideals, that their teachers talk like tradesmen and, when they graduate, discover that the leaders of the profession are merely successful tradesmen in white coats, then all is lost. Under these circumstances, the chances of an ethical profession surviving are smaller than that of a snowball in the streets of Singapore.

Ours is a noble profession but it will not stay noble unless its members are individually seen to be noble in their aspirations and endeavours. We must at all cost cling on to certain constant values as a profession, most of all an invariable respect for human life. If our professional ethics suffer brain stem death, then the annual ventilation of SMA Lectures will not keep off the stench of dissolution.

But I believe the high ideals of medicine will prevail. I believe that the practice of our art of itself tends to enlarge the conscience and humane impulses of its pracitioners. I believe that society as a whole needs in the most profound way the existence of physicians that people can respect and trust, next only to their separate gods and this will force the profession [1] against the threats to our ethical standards lie in increasing awareness of these issues both within the profession and without. The profession must provide leadership in discussing ethical issues. We should discuss these issues with dignity and defend our ethical positions with passion and when the community sees that we stand up for values, and not only for our personal advancement, then they will be with us. Whatever the technology, we must keep the doctor - patient relationship at the heart of the practice of medicine. We live on the threshold of the 21st Century and we must prepare for the future by refining our ethical concepts and developing the application of our ethical code so that the medical profession is seen to be firmly on the side of those in our care, willing to defend their human rights and in whose care their rights will be safe.

In conclusion, may I remind you of the first Aphorism of the Hyppocratic Collection, whose humility and wisdom Should be our guide.

"Life is short and the Art long, opportunity fleeting, experiment dangerous and judgement difficult".

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[1] back to its ancient role. Our protection as a profession

A NEW DIMENSION IN NMR

By Thomas H. Maugh

Two-dimensional nuclear magnetic resonance(2D-NMR) spectrometry may well be the fastest growing area of spectrometry today. While there are, in theory, few things that can be done by 2D-NMR that cannot be done by conventional NMR, in practice there are vast differences. In general, 2D-NMR does things more simply and more quickly (when interpretation time is considered); in many cases, furthermore, interpretation of the resultant data can be performed by a novice rather than by the skilled spectroscopist required to interpret conventional NMR studies.

NMR can be performed on any atom having a nucleus with nonzero spin angular momenta or, equivalently, a magnetic dipole moment; typically, that is an element with an odd atomic number, such as hydrogen, carbon-13, nitrogen-15, oxygen-17, and so on. The sample is inserted into a high magnetic field, which orients the dipoles. The dipoles are then perturbed by a radio-frequency (r-f) pulse, and their subsequent collective behavior monitored as a function of time. Fourier transformation of the resulting amplitude-time function produces the characteristic NMR spectrum, with each resonant nucleus giving rise to a peak at a position on a frequency scale. The position of this peak relative to a standard is called the chemical shift and is characteristic of the electronic environment of the nucleus. The signal for each chemical shift, furthermore, is split into two or more peaks as a result of coupling between nuclei transmitted through bonds; in effect, the dipole of one nucleus "senses" the orientation of the dipole in an adjacent nucleus.

For simple molecules, the spectrum is easy to interpret. As the molecule becomes more complex, individual peaks begin to overlap and interpretation becomes more difficult. For very large molecules and polymers, interpretation becomes almost impossible without the use of sophisticated techniques that aid in assigning resonances to specific nuclei. 2D-NMR is a technique that separates many of the magnetic interactions that are jumbled together in a conventional spectrum. It was developed in the early 1970's by Jean Jeener of Universite Libre in Belgium and by Ray Freeman and Richard Ernst at the Varian Corporation; Freeman is now at Oxford University and Ernst is at Eidgenossische Technische Hoochschule in Zurich.

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Perhaps the best analogy that can be used in explaining the difference between conventional and 2D-NMR is the difference between one-dimensional and two-dimensional thin-layer chromatography (2D-TLC). In conventional TLC, a specific solvent system is used to elute the samples along one dimension of a TLC plate. In 2D-TLC, the plate is rotated 90° after the first elution and eluted with a second solvent system to separate components that were not separated by the original solvent system.

In 2D-NMR, the second dimension can be achieved by several methods. The simplest way, perhaps, is to plot the spectrum for one nucleus against that for a second type of nucleus in the same compound. A proton spectrum might be plotted against the carbon-13 spectrum, for example. When this is done, the plot gives a direct indication of which protons are coupled to which carbon-13 atmos.

In this and other cases, the second dimension is achieved by introducing a second r-f pulse (or set of pulses) before relaxation from the first pulse is complete. By varying the timing of the pulses, it is possible both to tune (in effect) the spectrometer to each of the couplings in the sample molecule and to perform different types of experiments. A Fourier transform of the collected data provides a conventional NMR spectrum. A second Fourier transform of the same data - that is, a transform of the transform - provides the second dimension.

The result is a two-dimensional plot such as that in the accompanying figure. The diagonal represents the actual one-dimensional spectrum of the sample. As is apparent, many pairs of data points on the diagonal are accompanied by symmetrical data points on both sides of the spectrum, arranged so that the four points form the corners of a square. This arrangement indicates that the nuclei which produced the two resonances are correlated. In a proton spectrum, for example, this might mean that the protons responsible for the signals are attached to adjacent carbon atoms.

Applications of 2D-NMR can be broken down into four general categories, all dependent on the same type of mathematics:

- The most common application is known as correlation spectroscopy or COSY. This approach involves correlation of groups that are thought to be coupled

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each other to prove that they are, in fact, coupled. A variant that provides similar information is called spin echo correlation spectroscopy or SECSY.

- The second most common technique is called J-resolved spectroscopy. It provides a way to separate the chemical shift of a nucleus from the coupling to other nuclei, thereby simplifying the spectrum and making it easier to assign each resonance to a specific nucleus.

- Nuclear Overhauser effect spectroscopy (NOESY) is a technique to measure the interaction of nuclei through space rather than through chemical bonds. It is thus a good technique for determining distances between nonadjacent residues in a peptide chain, for example.

- Multiple quantum transitions is a technique in which molecules in a sample are forced to absorb or emit several quanta of energy at one time. This is a very powerful technique which can be used, for example, to determine which carbon atoms in a molecule are connected to which other atoms. This is one of the least used applications, says Ad Bax of the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases, "because of the inherent low sensitivity of the experiment".

The use of 2D-NMR for small molecules is now "almost routine," says Bax, particularly in the pharmaceutical industry, where identification or confirmation of unknown molecules is very important, and among synthetic chemists. But perhaps the area of greatest excitement now, he adds, is in biochemical applications. About five or six groups in the United States and three or four in Europe are using the technique to study the conformations of polypeptides, proteins (up to masses of about 15,000 daltons), transfer RNA's, and so forth

Two-dimensional NMR is the only alternative to x-ray crystallography for determining structures, says Bax. If the assignment of spectral resonances to individual nuclei within a protein has already been accomplished, the three-dimensional structure of the protein can be determined, "in principle, overnight." If the resonances are not assigned it may take much longer, but potentially still less time than is required for x-ray crystallography. The problem is simplified if there are histidine residues, for example, in the active site, since they are easier to assign.

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The same is true for other types of materials. Brian Reed of the University of Washington argues that 2D-NMR will almost completely replace x-ray crystallography for determining structures of tRNA's. Unfortunately, adds David Cowburn of the Rockefeller University, a lot of the best work on polymers has been performed by industrial scientists who have not been able to publish all of their results.

As versatile a technique as 2D-NMR is, there are still several problems associated with its use. The most important is the time required for data acquisition and workup. Where a conventional FT-NMR spectrum might have 2000 data points for each of 256 or 512 scans accumulated for a spectrum, a 2D spectrum will have a 2000 x 2000 array of data points for each. Quite obviously, this requires a lot of data storage space. The collection time for this data may range from an hour to a whole weekend. For 2D-NOE, furthermore, it is often necessary to perform each experiment three to four times.

Once the data is collected, each of the 512 scans must undergo a Fourier transform, which is a very time-consuming process. If the NMR instrument has only one central processing unit (CPU), the transform process must be interrupted each time a data point is collected, which further lengthens the time required. Many investigators now prefer to perform the transform on a larger computer separate from the NMR. One step to help alleviate this problem is the introduction by Varian of an NMR containing two 32-bit CPU's that operate independently, one for data collection and one for data processing.

Another problem is the size of the memory associated with the CPU. Most 2D-NMR spectrometers have only 128 to 256 kilobytes of memory, so only a small portion of the data matrix can be worked on at any time; this result must then be written onto a disk and new data read. The read/write process takes much more time than the actual computation. The Varian instrument has a 16-megabyte memory, so that the CPU must access the disk only about a tenth as often. This means that a computation that takes hours on another instrument might take only minutes on the Varian unit. Even this may not be sufficient, however. Many users argue that the

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instruments should use Winchester hard disk drives; these are not only faster but they also store more information. Many investigators also complain that the programs produced by the instrument makers for running a program of second pulses are not optimum for many of the less common uses.

In sum, says Cowburn, 2D-NMR has many benefits in addition to those already cited. Because the instruments have increased sensitivity, spectrometry of unusual nuclei and of solids will also become easier. "Many barriers", he concludes, "will simply disappear".

(Science, 224, 4644 (April 6, 1984) pp. 46-47)

SEWAGE AS A VERSATILE RESOURCE

By P.C. Bhattacharyya

One will not be right to regard sewage only as a source of obnoxious smell and a breeding ground of mosquitoes and other disease-carrying bacteria. Today, sewage is regarded as a versatile resource. It can be processed for making drinking water and even for uses for agricultural and industrial purposes. Various countries including Poland, Germany, China, USA, USSR, Indonesia, Hungary use sewage for culturing fish and making soils for cultivating field crops. Sewage-fed fish culture as a commercial venture is also undertaken in India in the various states including West Bengal. The project is more beneficial than using fertilisers. In addition, disposal problem of sewage can be solved.

Besides industrial wastes, domestic sewage is also harmful. It contains human excreta and also many dirty materials including several microorganisms. When sewage disposal is not properly managed, several diseases such as typhoid, polio, dysentery, cholera may occur in an epidemic form. For want of dredging the canals also, navigation may also be hampered. During rainy seasons, both sides of the canals may be flooded. The sundry water leaves the residue making it a breeding place of insects. But these problems do not arise when treated sewage is applied in the agricultural fields. In India, there are about 132 sewage farms. These use about 225 million gallons of sewage each day.

Considering the potentialities of sewage, there is need for more sewage farms. The developed nations like London. Paris, Berlin provide good number of sewage farms and use treated sewage for increasing crop productivity. One advantage in using sewage is that it provides also substantial revenue to the municipalities and the corporation. Consequently, regular dredging may be highly beneficial. Fertilisers cost may be cut on one hand, disposal of sewage may be solved on the other. Wise disposal may earn revenue from which dredging expenditure may also be compensated. The silts recovered may be utilised in making bricks. At present, sewage sludge is mostly applied to filling up low lands. This way of disposal of sewage affects environment. Underground water is made unfit thereby for drinking purposes.

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In India the quality of discharged water after domestic & industrial use is also estimated to be 3,000 million litres. But it is unfortunate that until now, not more than 2 per cent of it has been utilised for fish culture although by using domestic sewage as source of manures, annual fish production can greatly be improved. Germany, China Indonesia and other countries obtained fish. Production was about 2.5 to 4.00 tonnes per hectare per annum using sewage only as the manure source. One advantage is that this way of culturing fish involves meagre investment.

Fish converts biowastes into edible protein. Bacteria, fungi, Zooplankton and algae degrade complex materials such as proteins, urea, cellulose, fats, carbohydrates present in raw sewage into an effluent rich in potassium, nitrogen, phosphorus etc for culturing fish.

Sewage water, therefore, can be transformed into fertile waters by stagnating it for some days. The excess of water drained out from the sewage-fed fish ponds can also be used for irrigation purposes particularly for cultivation of vegetable crops, cononut palms, various fodder crops etc. Income from this source can also vary from 7.5 tonnes to 8.5 tonnes per hectare per annum depending on survival of the fingerlings.

Application of sewage is not made only to increase crop productively but also to raise soil productivity, India being a vast potential of organic wastes having sufficient plant nutrients, it may have an ample opportunity to use it. In addition, the sludge that is formed during treatment of sewage can also be potentially applied for the said purpose since sewage sludges are predominantly organic in nature and consist of about 40 to 60 per cent of them. Using sewage sludge on agricultural lands may, therefore, be a potent way of managing sludge disposal too. Sludge, in fact, can be applied to maintain soil productivity, environment and minimise impact on healths of animal and man.

However, sludge cannot be applied in any way. Considering the environmental impacts from excessive concentrations of nitrogen and toxic elements especially cadmium, the US Environmental Protection Agency formulated a policy for applying sludge in the Agricultural fields. It has set up a standard such that in 50 years, cadmium concentration exceeds 2 kg per hectare and that proportion of nitrogen is to be such

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so as to fulfil crops nitrogen requirement or to meet the losses of nitroger that take place through dentrification and volatilisation. The US, the UK, Netherlands, Sweden, Germany have followed this standard.

A recent report by the Central Board for the Prevention and Control of Water Pollution revealed that production of sludge in India is poor. Being dependent on sewage treatment, it receives little attention uptil now. The report shows that only 37 per cent of the liquid wastes receive some form of treatment. Sludge can serve as an important resource of plant nutrients with minimum environmental hazards. It is reported that various nitrogen, phosphorus and potassium manures can be obtained from the urban and rural wastes. According to a report about 11.025 million tonnes of nitrogen. 5.527 metric tonnes of phosphorous pentoxide and 9.542 metric tonnes of potassium oxide may be obtained from these sources.

(Science Service, 3, 4 (Feb. 16-19, 1984) p.7)

HAZARDS OF POLUTION CREATED BY INDUSTRIAL EFFLUENT

By B.B. Sundaresan

Chemical pollutants from industrial wastes vary from short lived to the permanent and from the locally to the globally distributed. Their threat to ecological systems is generally proportional to their persistence and ubiquitousness. The pollutants that are of concern to ecosystems are those chemical elements (Cd, Pb, Hg) that do not break down and those that resist degradation (PCBs) for years or even decades. These chemical pollutants have been found to enter the aquatic and human food chain through bio-accumulation and biomagnification.

Methyl mercury present in the wastewater discharged from an acetaldehyde manufacturing process (using mercury as catalyst) entered the food chain through bioconcentration by fish in Minamata Bay, Japan. Fish from this area caused a neurological disease known as 'Minamata disease' in the heavy fish eaters which resulted in fatal cases as well. Such episodes of heavy metal accumulation in aquatic food chain organism as well as in plant foods have been reported around the globe. The 'itai-itai' disease in Japan after World War II was traced to cadmium poisoning. Cadmium present in the wastwater from a mine processing copper, lead and zinc was transported by suspended particulates to paddy crop irrigated from the Jintsu River which received the process wastewaters. Studies showed good correlation between the disease and the cadmium concentration in the rice. It has been shown that in several instances the metal enrichment surpasses that of natural environment many times over; (i) metal levels of organisms are 100 times greater in polluted inland and coastal waters than in less contaminated areas, but no food chain enrichment in classic sense of the term as found for organic pesticides (DDT); (ii) upto 100 times 'normal' levels of Cd were observed in water samples; and (iii) sediment samples indicated mercury levels over 10,000 times those of uncontaminated areas.

A large fraction of the sparingly soluble metal components are although, immobilized in particulates and relatively harmless, one can not overlook the fact that these metals can be released by the numerous processes due to anthropogenic and microbial influences. Since the latent toxic effects of heavy metals not

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clearly understood and until all doubts about the effects on the biological food chain and drinking water supplies removed, heavy metals should be kept to a minimum in all aquatic systems.

A variety of organic chemicals which fall under the category of recalcitrant compounds (chlorinated pesticides, PCBs, etc.), when released into aqueous environment through different routes, get enriched in the aquatic food chain organisms through the classical biomagnification process. It has been observed that the higher the trophic level of the organism in the food chain the more it receives through food.

In Clear Lake, California, plankton accumulated 250 times the DDD, similar to DDT, in water, fish 12,000 times and fish eating birds 80,000 times. Aquatic birds near the top of the food chain have been found to contain 10^7 times DDT found in waters from which they feed. Such a biological magnification of pesticides and other organics may result in making the fish and birds unsafe or even hazardous for human consumption. Greater magnification is reported with organochlorine derivatives because of their persistence and higher affinity lipids.

Phosphate and nitrate popularly known as nutrient elements in the ecosystem, discharged through industrial and domestic wastewaters as well as agricultural run-off, do not cause any direct hazard but are found to induce eutrophication in lakes and reservoirs. Phosphate, even in small quantities, stimulates algal blooms which are responsible for the degeneration or death of many natural lakes polluted by industrial and domestic wastes. Lake Zurich in Switzerland, the four lakes in vicinity of Madison, USA; and Lake Erie, Canada are some of the classical examples of induced eutrophication.

Discharge of large quantities of oil along with the effluent from an Oil Refinery set the river aflame and resulted in the suspension of water supply to the town and the refinery near Monghyr, Bihar in 1968.

A study conducted by NEERI in 1969 on the water quality of the Damodar river in the industrialised Asansol-Durgapur region, showed that the river water had a BOD, 30 mg/l; phenol, 3mg/l; iron, 8mg/l and cyanide, 0.3 mg/l and was due to discharge of large volume of industrial wastewaters from steel, coke oven, coal gas and coal based chemical industries.

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The river water was found unfit for drinking or for fish life. Discharge of untreated wastewater from a group of dye industries into the last stretch of the Kalu river near Bombay, resulted in lowering the pH of the river water to 4.0. The Ganga at Kanpur received the domestic wastewater from 1.3 people living in Kanpur (1971 census) along with the wastewater from 45 tanneries, 10 textile mills, 3 woollen mills, 2 Jute mills and a number of chemical and pharmaceutical industries.

Hooghly estuary near Calcutta receives untreated domestic and industrial wastewaters to the tune of 6.7×10^7 m^3/d of which industries contribute 66% with a pollution load of 52 tonnes/day. The bacteriological quality of the raw water from the six water works and bathing ghats located on either side of the bank was alarmingly bad since faecal coliforms were found to be higher than the standards laid down for bathing ghats. The plankton counts reduced appreciably and practically no fish observed in the 100 km stretch between Kalyan and Birlapur of the Estuary.

The Upper lake at Bhopal being a water source for the city is shown to be polluted more intensely at points within a few metres of five of the six water intake wells due to the discharge of sewage from the residential areas in and around the intake points. The other lake known as Lower Lake receives wastewaters and is rendered useless because of eutrophication and vegetative growths.

Large scale fish killed in the estuary near Goa was reported to be due to discharge of wastewater containing ammonia and arsenic from a nitrogenous fertilizer factory. Zingde et al reported arsenic levels in estuary waters of Zuari river to be as high as 66 mg/l in selected locations. The fauna and flora of coastal and estuarine waters around Goa were found to contain trace metals. These studies also revealed the presence of recalcitrant chemicals in the marine environment around the Indian sub-continent which could be attributed to release of industrial effluents.

The Water (Prevention and Control) Act, 1974 by the Central Government and its subsequent adoption by All the States (excluding the 5 North-East Hill States) has been a significant step in safe-guarding environmental quality. The Central and State Boards have initiated actions in regard to: (i) water quality monitoring programme to collect baseline data on river water quality for classification and zoning of water

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for best use; (ii) preparation of comprehensive industry documents for suggesting types of treatment and developing Minimal National Standards (MINAS), based on techno-economic study, for discharge of treated wastewaters; and (iii) survey of industrial and municipal wastewater collection and treatment facilities to arrive at the inputs required for the control of pollution. Institutions like NEERI Technological Institutes and Universities have been providing the required R&D inputs for the development of pollution control technologies.

A recent survey carried out by the Central Board revealed that the total industrial wastewater generated in the country constitutes only 10 per cent by volume of the total wastewater generated by all urban settlements. It is observed that out of 27,000 large and medium scale industries, 1700 have been identified as water polluting industries (excluding those from Maharashtra State). Further in the beginning of 1981 there were 460 industrial wastewater treatment plants in operation of in commissioning stage. Since 251 more treatment plants either under construction or under planning, it can be assumed by the early 1982, there were 711 industrial wastewater treatment plants in operation.

In addition, hazardous semi-solid and solid residues from industries dumped on land surface, may release pollutants due to leaching into surface and ground water sources, for which adequate regulatory measures will be needed.

Fresh water resources of the World being limited, get increasingly polluted due to urbanisation, industrialisation and agricultural practices. Toxic compounds hitherto unknown are being detected in several water supplies even in developing countries. Further water resources being finite and future demands for water increasing, recycle and reuse of wastewater for industry and agriculture have been recognised as a viable alternative.

Xenobiotic compounds released into industrial wastes, by anthropogenic activities, are not effectively removed in the conventional biological treatment processes and thus reach plants through soil, aquatic fauna and flora through rivers, lakes, coastal waters and oceans. They do not just disappear

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by natural mechanisms. The hazardous potential of several xenobiotics as well as heavy metals and the damage caused to several facets of ecosystem have been recognised and well documented. Although, mode of transport of several substances present in industrial wastes through environmental materials and their acute effects on human health is known, there is much less information about their long term exposure or ingestion. If the current trend is allowed unchecked the environmental degradation would reach a stage of upsetting the life supporting capabilities of the earth before the end of the Century.

(Science Service,3 ,4 (Feb. 16-29, 1984) pp 4-5)

SEARCHING FOR NEW SOURCE OF ENERGY

By Stanif..th Webb

Oil companies drill exploratory wells and bring up samples, which are then analysed for the richness and maturity of the organic detritus they contain. Diagenesis, the process whereby plant material matures into oil and gas, takes about 150 million years; strata which have not had as long as that to mature are unlikely to contain useful amounts of oil or gas. Conventionally, samples are analysed by two techniques. One is lithographic logging, in which the types and quantities of fossil material are analysed. The other is litrinite reflectance, in which the colour changes found in the organic matter in the sample are analysed. Successively higher temperatures at different times will have caused successive colour changes from cream through yellow and brown to black. The colours record the temperatures to which organic material has been exposed and this, too, provides data about its maturity.

In 1974 a team led by Dr. John Bather in the University of Manchester Institute of Science and Technology (UMIST) department of chemistry, then working with the support of the UK department of Energy and the Burmah Oil Company, began to develop an alternative technique using analytical chemistry instead of fossil or colour records. Building on earlier work, they looked at the chemistry of samples using pyrolysis, heating a sample in the absence of oxygen and identifying and measuring the amounts of volatile gases that are evolved one by one at increasing temperatures, as solid and liquid organic compounds volatilize. Over four years' research Bather established the patterns of volatiles given off with increasing time and temperature by samples containing organic matter of different degrees of maturity. He found that the patterns repeated themselves extremely well with similar samples, giving rise to the idea that the technique might be used to analyse samples from exploratory oil drillings. This led to the development of system used for a commercial service.

Volatile compounds produced during pyrolysis are analysed by gas chromatography and mass spectroscopy, under the control of a computer which effectively automates the process. Breakdown of a complex mixture of organic compounds known together as Kerogen is observed. Ingredients of Kerogen, terpenes and steareses for example, the molecules of which are

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normally held together by links between sulphur, carbon, and nitrogen atoms, break apart and volatilise. Computer programmes analyse such things as the ratio of volatile organic compounds with odd numbers of carbon atoms to those with even numbers. In mature strata that promise to be rich in oil the ratio is near to equality; in very immature strata it is about five to one.

The way in which the complex molecules of chlorophyll, the green pigment that traps sunlight in green plants, have broken down is another factor measured. It provides data about the maturity or otherwise of the strata from which a sample has come. These and several other things are compared automatically with the results obtained by pyrolysing samples of known maturity.

The whole process takes about one hour per sample, as compared with between four and fourteen days for conventional techniques. During the drilling of an exploratory well an oil company takes an average of some 400 samples, of which about half need to be analysed before a decision can be taken to pursue the work or to abandon it. Each day's offshore drilling costs about £60,000 and the average exploratory well costs about £6 million before drilling is complete.

Only one in ten such wells look promising enough for oil or gas to be extracted and only one in three of those eventually turns out to be a good commercial proposition. So, each economic well trails behind it a cost of around £180 million in wasted time and drilling non-productive wells. Obviously, anything that cuts the time wasted in deciding whether to proceed with wells is going to save a lot of money.

With this in mind, Bather's team has set up a company called Datachem. It came into being late in 1981 and is now analysing samples provided by oil companies, at a cost of £300 per sample. Samples weigh only between 10 and 50 grams, so they are easy to send around the world.

Meanwhile, in a section of applied molecular biology set up about three years ago at UMIST, scientists have made it possible for one of the alternatives to petrol and diesel oil, namely fuel alcohol, to be produced more cheaply. Alcohol is produced through the fermentation of sugars by yeasts, microscopic fungi which break down sugars to produce the energy they require, meanwhile producing ethanol

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and carbon dioxide as waste products. The limit to the strength of the alcohol solution that can be produced by yeasts is set by the fact that above a certain concentration alcohol kills them. Normally, the performance of yeasts as fermenters falls off sharply when concentrations rise above roughly ten per cent of alcohol by volume, and they are killed before concentrations reach fourteen per cent. Beyond that strength, alcohol for use in fuel or for other purposes, including in spirits, has to be distilled to make it more concentrated. Expensive energy is used in the process.

Obviously, it would be advantageous to develop strains of yeasts able to work in higher concentrations of alcohol and to work more efficiently in concentrations that impair the performance of existing yeasts. But the effects of alcohol on yeasts are complex; growth rate, viability and fermentation rate are affected separately, making it very difficult to use conventional techniques to identify and isolate mutants that have a better alcohol tolerance. Dr. Stephen Brown in the department of biochemistry and applied molecular biology developed an alternative and ingenious approach which has proved successful. They used a feedback system in which the intensity of selection in yeasts that are made to evolve to become more tolerant is fixed by the culture itself, via a feedback circuit.

The technique involves taking the carbon dioxide evolved by the experimental culture and using it to control the switching on and off of a pump delivering alcohol to the culture. When the culture adapted to greater concentrations, by producing mutant strains that were more tolerant, the production of CO_2 increased and more alcohol was fed to the culture. Eventually, the rate of CO_2 production fell, at which point the pump was automatically switched off.

In this way the UMIST team succeeded in producing strains of yeasts which were able to tolerate higher concentrations of alcohol than the best brewers' yeasts, and had fermentation rates of more than twice those of the best lager yeasts in the presence of a concentration of ten per cent alcohol.

This work has been supported by the UK sugar refiners Tate and Lyle and is likely to find its first applications in fermenting sugar cane into fuel alcohol.

(PTI Science Service News, 3, 10 (May 16-31, 1984) pp. 2-3)

THE MEANING OF ENERGY CONSERVATION

By R.C.J. Tolfor

The use of the term 'energy conservation' is really inappropriate since it has suggestions of doing without, of having to suffer to succeed, and a hair shirt approach.

ACEC defines energy conservation as the adoption of any measure that cost-effectively increases benefits relative to the amount or cost of energy consumed, i.e. conservation measures must be economically sound with the benefits outweighing the costs. Reducing energy use per se is not included in this definition, but switching from a scarce and more expensive source of energy to one that is more plentiful and cheaper would be included if the benefits outweighted the costs. So also would improvements in energy efficiency that result from technical change.

The importance of energy efficiency:

When economic viability and possible take-up rates are taken into account, the realistic saving in UK energy consumption is about 20% by the year 2000 for all sectors - worth more than £ 5 billion at today's price at the turn of the century and so there is a lot to go at!

The following factors demonstrate the importance of a continuing drive towards greater efficiency:

- Cost effective energy saving measures will make industry, and indeed the country, more efficient, competitive and profitable and better equipped to win and hold markets;

- By reducing pressures on energy supplies, particularly oil dependency among OECD countries, more efficient use of energy is likely to strengthen the chance to contain energy prices worldwide;

- In many cases energy efficiency measures can be introduced without the environmental controversy that often surrounds new supply projects. The impact of energy supply activities can no longer be considered small and the external costs of supply are coming under ever-increasing scrutiny;

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- In relative terms, for a given quantity of energy, the costs of improving energy efficiency are often less than the costs of supply; many energy efficiency investments offer distinct benefits in terms of their high returns, short lead times and low technical and commercial risks;

- Energy efficiency measures will provide spin-off benefits on employment not only through stimulating the provision of energy saving equipment and services, but also by increasing the competitiveness of the nation.

Progress in the UK

On a heat supplied basis, energy consumption in the U.K. fell by 11% from 1973-1982 (i.e. 244 to 217 Mtoe). Industrial energy use fell 35%, while domestic use rose 4% and transport by 8%.

What lies behind these figures? ACEC has examined the trends in some depth and has concluded the U.K. progress in energy conservation has been poor compared with many other countries. While there has clearly been a quickening in the rate of fall in the energy intensity of the UK economy (ie primary energy consumption/GDP) over the past decade much of this has been due to the decline in industries, ie structure change.

In the industrial sector, two factors have accounted for most of the 35% decline in energy consumption. About 20 percentage points have been due simply to reduced industrial output. A further key factor has been the change in mix of industrial output itself, away from energy intensive activities - the most notable example being iron and steel production. After account is taken of these factors the rate of increase in real energy efficiency in industry appears to have shown little improvement compared with the rate of progress before 1973, in spite of the large potential for cost-effective measures.

A key factor in this has been the lack of economic growth and so the slower introduction of technological changes. These and the relatively high fixed energy costs at a time of low capacity utilisation have largely offset the benefits from low cost 'good

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housekeeping' energy-saving steps and other factors such as the closure of surplus inefficient plants.

The better progress in energy efficiency shown by some of our industrial competitors seems to be associated with better growth in their GDP and higher rates of industrial investment. Indeed, a higher rate of economic growth in the UK, with consequent introduction of new technologically advanced, and more energy-efficient plant and processes - together with attendant higher profitabilities, is likely to be the biggest single factor in improving future energy efficiency in industry.

The role of pricing:

Rapidly rising real energy prices have been an important element in bringing about improvements in the efficiency of energy use and succeeding governments have increasingly presented the economic pricing of energy as playing a central role in energy conservation policy and it has now come to be regarded as the main plank in the policy.

ACEC, however, believes that whilst pricing has played a very significant part in reducing energy consumption, many opportunities for cost-effective energy conservation investment are not being pursued and there are large and important areas that are not being sufficiently affected through the dominance of other factors, eg in public sector housing and other rented houses. In ACEC's view, energy conservation policy requires a similar emphasis to be given to all aspects of energy conservation policy such as information and advice, financial incentives, removal of institutional barriers etc.

There is much scope for debate on defining what is meant by 'economic' pricing of fuels. A widely-stated view is that economic pricing should reflect the cost of supplying fuels to all sectors on a continuing long-term basis. But, there are at least four different aspects to be considered viz market forces, longer run marginal costs of supply, year-by-year financial targets set for the relevant energy industries, and fuel prices in countries with whose products UK manufacturers are competing. ACEC believes the last factor is especially important for the industrial sector. While some countries may well enjoy natural low-cost sources of energy supplies, others may have governments that subsidise energy prices directly or

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indirectly, or offer relatively advantageous tariffs. ACEC believes that, whilst the definition of economic pricing which reflects the cost of supplies on a continuing basis may be appropriate from a general economic viewpoint, its effect on industrial firms could run counter to the reason for promoting energy efficiency in industry - which is to improve cost-effectiveness and hence competitiveness.

Overall the choice of method to encourage energy efficiency depends very much on the urgency of the need, the acceptance of the method by the public and the need to balance conflicting interests.

Energy supply v energy conservation investments:

While accepting that comparisons between investment in more efficient energy use and energy supply are difficult, and that they may not be interchangeable, it is clear that in many cases energy-efficiency projects are required to earn a higher rate of return than some supply projects. I do not propose to compare investment in supply, and in more efficient energy use, as alternatives; but I am concerned that there are a significant number of constraints to highly cost-effective and worthwhile energy efficiency investments. Although in many cases these constraints have been recognized for some time, insufficient steps have been taken to mitigate or remove them. Throughout the economy there are energy efficiency investments which are extremely cost effective on their own terms, have the potential to apply national resources more economically, but are being foregone.

Information and advice:

ACEC's recommendations include:

- A substantial increase in the Government's publicity budget to support a new and more vigorous campaign, emphasizing the message to use energy more efficiently rather than to conserve energy perse;

- special emphasis should be given to the industrial sector and, in particular, to the securing of top management commitment. By and large, the Secretary of State appears to be acting on this advice.

Financial incentives:

ACEC recognizes the current constraints on public spending and appreciates that in the industrial sector, for example, the final responsibility for the efficient

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use of energy, whether by capital investment, good housekeeping or effective operating practices, rests with individual management.

In considering direct financial incentives ACEC has thus concluded that these must have a relatively limited role in relation to the total available investment potential for undertaking energy efficiency measures. The costs of providing general subsidy support for energy saving could be very high indeed. For example, in 1982 British industry spent some £ 6.5 million on energy. Various studies have indicated that it could reduce this bill by around £ 1 billion a year through investment in cost effective energy efficiency measures applied to existing plants and buildings with paybacks of three years or less - thus placing the investment costs involved at perhaps between £2 and £3 billion. A very large sum would be involved in subsidies to realize this potential and Government support for expenditures of this order is neither practical nor desirable.

Government should undertake that current schemes such as the Coal Firing Scheme, the Energy Conservation Demonstration Projects Scheme (ECDPS) and Schemes of Support for Innovation will be available throughout the life of the present Parliament.

Government should assess the case for extension of its support for energy efficiency through innovation to cover schemes utilizing best-proven technology via low interest loans repayable from savings made.

Regulations:

ACEC is not asking for any new major legislation but Government however should examine as a priority, means of overcoming the conflict of interests in tenant/landlord relationships regarding the efficient use of energy. This could involve the restoration of specific allocations for energy efficiency in the public sector and some form of incentive and/or legislative change in the private sector.

Technology:

The development and adoption of innovative energy efficiency technology should be speeded up by improving its effective exploitation through for example: more R&D joint ventures between the private and public sectors and ensuring the criteria for

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replication of projects under the Energy Conservation Demonstration Projects Scheme are not too stringent given the current climate of recession. Consideration should also be given to encouraging the adoption of on-board computers for heavy goods vehicles to supersede existing tachographs and to establishing centres of information and advice for new sensor developments.

CHP

In the area of combined heat and power (CHP) the Government should encourage setting up private utility companies to build and operate CHP plants with a view to selling steam and electricity to industrial users. This may require some sort of safeguard to ensure that such companies would be protected from the effects of changes in Government policy relating to energy pricing.

(Energy World, (April, 1984) pp. 3-5)

AGRICULTURE AND CARBON DIOXIDE

by Paul E. Waggoner

If the levels of carbon dioxide in the atmosphere increase as expected, will agricultural productivity decline?

If the amount of carbon dioxide in the atmosphere continues to increase as we expect it to do, shall we have more or less to eat? The crops that feed us stand outdoors in the wind, rain, and frost. Except for 8 kg of fish, all the 635 kg of food that each American eats yearly, and all the feed for our animals, is grown on 150,000 ha of cropland and rangeland exposed to the annual lottery of the weather. Protecting all our staple crops from drought by irrigation or sheltering them in greenhouses would not be practical: even irrigation depends on precipitation in the long run, and it would be too expensive to build and maintain enough greenhouses. Grocery prices for all and the hunger of the poor remind us that our food supply is at the mercy of slight changes of temperature and the timing of a few drops of rain. The more difficulty a country has in feeding its people, the more drastically it could be affected by seemingly minute changes in the climate.

Although later paragraphs include technical calculations of changes in American agricultural productivity that reflect expected variations in the weather, the effects of changing temperature and precipitation on agriculture are too complex to be distilled into a few numbers. Two examples from history will help show in general how farmers are affected by atmospheric change.

The years from A.D. 1301 to 1350 were unusually rainy and cold in Europe, and the changing climate meant that grain could no longer be cultivated in Iceland and in parts of Scandinavia as the growing season became perceptibly shoter (Tuchman 1978). This medieval example demonstrates both that the length of the season as well as the mean temperature is critical and that the impact of climatic change increases toward the poles.

The second example is the dust bowl of the 1930s. In addition to the more familiar consequences of the disaster, the drought encouraged the proliferation of certain pests. The greatest losses of crops to wheat rust during the period 1921-50 occurred in the 1930s. The prickly pear cactus spread east, invading 1.6 million ha of western Kansas. More young jackrabbits survived in the drier weather. The grasshopper population also soared,

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and the insects so devastated the vegetation in South Dakota that jackrabbits in that state, faced with starvation, migrated into Nebraska (NRC 1976, Schlebecker 1953).

Moving from the general evidence that weather affects agriculture to specific estimates of how productivity will vary requires a projection of specific changes in the weather. The concentration of CO_2 in the atmosphere has risen from 280-290 ppm in the 1860s to about 340 at present. It is not expected to reach more than 400 ppm by A.D. 2000, but it could be 430-740 by 2050 (NRC 1983). American crops are in the zone between 35 and 49 degrees of latitude that is predicted to experience changes in weather as the level of CO2 increases. For example, a doubling of atmospheric CO_2 would cause a 3° C warming at the US-Canadian border, according to Manabe and Stouffer (1980) a rise of 1° C in mean summer temperature length-ens the growing season by about 10 days (Kellogg 1977).

Less precipitation has also been predicted to result from increased CO_2 based on the paleoclimatic record and physical models. If higher levels of CO2 make our climate comparable to that of the Altithermal period of 4,000 to 8,000 years ago, the climate in the central plains of the United States, where the majority of our cereal crops are grown, will be drier (Kellogg 1977). Three physical models of increasing geographic detail also predict drier summers at middle and high latitudes (Manabe et al. 1981). Summer would begin earlier, and more moisture would evaporate from the soil.

We can consider the consequences of an increase in atmospheric CO2 to about 400 ppm by the year 2000. We can also evaluate the results of a mean warming of about I C and an expansion of the growing season by several days in the northern United States, and more frequent drought nationwide if the country receives 10% less precipitation and experiences slightly more evaporation.

Although only about one-seventh of the cropland in the United States is irrigated, it produces a disproportionately large share of the market value of the crops. Since irrigation uses runoff and runoff is often only the small difference between precipitation and evaporation, changes in temperature and precipitation can cause relatively greater changes in the supply of water for irrigation. In an important example, a decrease of a tenth in precipitation plus a warming of 1° C reduces the flow in the Colorado River by about 25% according to the historical record (NRC 1983). Thus irrigation which accounts for about half of all water consumption in this country,

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and the valuable crops that it produces seem particularly susceptible to a decrease in precipitation combined with a warming that increases evaporation and demand for water.

Direct effects of CO2

Since most of the dry weight of plants is derived from the reduction of CO2 to carbohydrates by photosynthesis, the concentration of CO2 in the air can directly affect plants in fact, Lemon (1983) has compiled an entire book on the effects. In all plants, photosynthesis involves the so-called C_3 process that converts CO_2 into molecules with three carbon atoms. Following the C_3 process, additional steps eventually produce carbohydrates. However, in some species, called C_4 plants, CO_2 is first incorporated at a fast rate into molecules with four carbon atoms, which are then transporated within the leaf to sites where CO2 is released, providing a high concentration of CO2 for the C_3 process.

The same enzyme that catalyzes the first step in the C_3 process can also catalyze on oxidation that leads to photorespiration, which consumes as much as a third of the CO2 the plant has absorbed in the light (Zelitch 1982). Photorespiration is slowed by high concentrations of CO_2 and hence occurs more rapidly in C_3 plants such as wheat than in C_4 plants, like maize, where abundant CO_2 is available for the C_3 process. Thus, when atmospheric CO_2 is relatively low, net photosynthesis is faster in C_4 than in C_3 plants. At higher levels of CO_2 however, the change in photorespiration per change in CO_2 leads to greater increases in net photosynthesis for C_3 plants than for C_4 (Akita and Moss 1973).

The nature of the products of photosynthesis and how they are transported to the sites where they are converted to starch, protein, and lipid may affect a variety of processes, including subsequent photosynthesis as well as the accumulation of carbon in a storage organ such as a grain. A higher level of CO_2 decreases photorespiration and thus indirectly affects nitrogen metabolism since ammonia passes rapidly through leaves during photorespiration (Lawyer et al. 1981). Because a plants yield depends on an adequate storage capacity or sink, to accept the products of photosynthesis, feedback mechanisms will decrease further photosynthesis if the sink is inadequate and might temper any increase caused by more CO2. Fortunately, the size of the sink and the yield [illegible] set by photosynthetic capacity (Evans 1975).

In addition to the production of carbohydrates, the water in plants can be directly affected, because CO_2 affects the stomates. While admitting the CO_2 essential

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for photosynthesis into the moist interior of the leaves, the microscopic stomatal pores in the epidermis also allow water to escape. In bright light the stomates of maize growing in pots narrowed when the CO_2 concentration increased from 300 to 600 ppm, and transpiration decreased by about 20%. Transpiration from pots of wheat, however decreased by only about 5% the contrast is assumed to the typical of the difference between C_4 and C_3 plants (Akita and Moss 1973). This measured loss of water includes evaporation from the soil, which is especially significant when the soil is moist and unshaded by foliage, and from wet foliage as well as from the interior via stomates. Nevertheless, mere narrowing of the pores conserves water, even in a crop with several hectares of leaf surface per hectare of land (Waggoner et al. 1964).

Logically, saving water by narrowing the stomates would conserve water in the soil and should reduce stress on the plant. Experiments on whether crops yield more when moisture is scarce and CO2 is elevated have produced ambivalent results, however (Gifford 1979, Sionit et al. 1980). Resenberg (1981) has reviewed at length the relation of increasing CO2 and how efficiently water is used.

Another logical connection is between nutrients and photosynthesis. As photosynthesis increases with increasing CO2 there will be more carbohydrates available for the plants growth raising the demands for fertilizer or available nutrients in the soil. Alternatively, a lack of nutrients could temper and benefit from more CO2.

Plants and microbes capable of fixing nitrogen would obviously have a new advantage if CO2 levels were higher. During one growing season, soybeans in air enriched to 500 ppm of CO2 fixed 40% more nitrogen than did control plants in normal air (Hardy and Havelka 1977). The increased nitrogen in the plants grown in enriched air would permit increased growth and then more photosynthesis in a continuing spiral.

Because the concentration of CO2 in the pores in the soil is 10-50 times greater than in the atmosphere, doubling atmospheric CO2 would probably not affect roots and soil microbes directly. However, if there were larger plants because of higher levels of CO2, there would generally be more organic matter in the soil, which would improve soil structure and fertility in the manner indicated by generations of experiments in green manuring.

The development of organs within a plant is distinct from their mere enlargement or growth, and one can reasonably ask if this development is effected by CO2 in the air. Although one species, cucumber, developed flowers and produced marketable fruit two weeks earlier

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Certain developmental events, such as the initiation of leaves and flowers are sensitive to changes in the soil and in the temperature. However, any change in the timing of flowering and other stages in the life of crops is not likely to be an important direct consequence of the projected rise in CO2.

Although variations in the environment can affect the way in which many diseases, insects, and weeds compete with crops, changing levels of CO2 in the atmosphere will logically have a direct impact only on weeds with fast photorespiration. When CO2 was increased, the C_3 velvetleaf, or Abutilon theophrasti increased its growth more than the C_4 maize, whereas the C_4 itchgrass, or Rottboellia exaltata, gained less than the C_3 soybean (Patterson and Flint 1980). In addition to promoting a gradual increase in growth, higher levels of CO2 might make it easier for some weeds to spread. For example, okra, which is a crop beginning to spread in the wild as a weed, can grow in cooler weather and presumably at higher latitudes if more CO2 is present (Sionit et al. 1981b). Since limiting nutrients and water failed to nullify the benefits of added CO2 to a plants hight and leaf area that effect the competition between crops and weeds for light, increased CO2 seems likely to affect that competition, sometimes benefiting the crop and sometimes the weed (Patterson and Flint 1982).

How do all the effects enumerated above work together to affect the yield ?It is indicated that crops exposed to elevated levels of CO2 for most or all of their growth will have a greater yield, but all of these crops except one were raised in chambers or greenhouses, where light is rarely optimum. Some of the experiments, however, subjected the plants to stress, which might mimic natural situations, and the soybeans were grown under chambers outdoors; other research conducted outdoors found that the yield of soybeans and other grain legumes increased about 8.1% per 33 ppm CO2 (Hardy and Havelka 1977), confirming the observation of Hardman and Brun (1971).

Three facts are clear. The yield of all crops was some what greater when CO2 was increased. However, the annual change in yield based on the projected rise in CO2 is similar to or less than the annual change actually achieved on the entire U.S. crop during 1963-70 as a result of improving technology and husbandry. There is little if any evidence that a lack of water or nutrients counteracts the effect of increased CO2 on the yield.

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Indirect effects of a warmer, drier climate

The changes in temperature and precipitation expected with the rise in CO2 render the preceding simple consideration of the direct effects of increasing CO2 on crops unrealistic. However, if we ignore any direct effects on crop growth, we can use two orderly means to calculate how the yields of crops will change if the calimate becomes warmer and drier. One approach, regression, compares past changes in yield to recorded changes in weather. The second method, simulation, uses the physiology of plants and the physics of their environment in a computer program to study the change in yield. Regression provides coefficients of, say, kg/ha/mm of precipitation. Simulations provide annual frequency distributions of yields in the present climate and of expected yields with particular changes in temperature and precipitation.

Thompson (1969) first estimated the effect of weather by the regression $Yi=a+biti+b_2x2_i+...bn \times ni$ in which Y represents kg/ha in the year i, a is intercept (or the mean Y less the sum of the products of the b terms times the mean Xs), bi the effect of technology in annual kg/ha, t the year i, b2 to bn the effect of a unit change in the weather in kg/ha for each unit, and X2i to Xni such weather factors as precipitation or temperature in the year i. This formula makes it possible to distill the effect of weather, factor by factor, from historical records compiled over decades.

A c mprehensive set of the b coefficients was estimated by NOAA, USDA, NASA, and the University of Missouri for wheat, maize, and soybeans in the American grain belt (Sakamoto 1978).

Table shows the complex effects of changes in the weather. For instance, in the Red River Valley, which includes eastern North Dakota and western Minnesota and is likely to experience a change in climate from rising CO2. If temperatures in April, the planting season, are 1 C warmer, the yield of wheat increases 21 kg/ha; on the other hand, if June or July is 1 C warmer, there will be more days that are hotter than 32 C, and the yield will decrease. South Dakota shows the effect of weather in the transition region between winter and spring wheat, where spring wheat is relegated to unfavorable sites in which the higher-yielding winter wheat will not prosper: higher temperatures in July have an especially adverse effect on the spring wheat grown in marginal conditions, reducing the yield 69 kg/ha for each degree. The effect of precipitation can also be seen in Table A decrease

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in precipitation is often compounded by an increase in potential evapotranspiration, which measures the demand for water.

To predict the results of climatic change caused by rising levels of CO2, the consequences of both warmer and drier weather must be calculated. For example, to estimate the change in yield of spring wheat in South Dakota if the weather becomes 1° C warmer and 10% drier, the regression coefficients in Table 2 must be multiplied by all the changes in weather. Combining a 1° C warming in July, two more days in June hotter than 32° C, an 8 mm decrease in precipitation from September to November, and a 16% decrease in the ratio of April precipitation to potential evapotranspiration would decrease the yield by 11%.

Farther south, in Kansas, the combined changes in temperature and precipitation would produce a somewhat smaller decrease. Two more very hot days would occur in May, and there would be 22 mm less precipitation from August to November, 4.5 mm less in March, and 10 mm less in June. The outcome of all this is a 5% decrease in yield.

After these examples, something must be said of multiple collinearity. If two climatic variables are correlated, their correlation changes the regression coefficient. The correlation may even produce a nonsensical value. In Table 2, the problem of multiple collinearity has been minimized by combining variables. For instance, precipitation and temperature are correlated, and both affect crops. The two can, however, be combined into a single variable that expresses that joint effect on a crop. Fortunately, the coefficients of Table 2 all make agricultural sense.

Mention also must be made of my changing the climate by 1 C and 10% of the precipitation uniformaly throughout the year. It is unlikely that warmer and drier weather brought about by increased CO2 would be so nicely arranged. Further, I have ignored extremes such as frost, assuming that they will be related to the means in the future as they have been in the past.

Despite all the provisos, the predictions of Table 2 for wheat and of similar tables for maize and soybeans make good sense. There are geographical and seasonal differences, with warming being sometimes favorable and sometimes unfavorable. But all the tables consistently indicate that, putting aside the direct effect of CO2 on crops, the projected change in weather by the year 2000 would cause moderate decreases of 2-12% in yield of the three major crops of the American grain belt.

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Simulations that assemble the physiology of the crop and the physics of the environment are alternatives for predicting the outcome of changed weather. An early simulation calculated a crop's photosynthesis from such factors as the photosynthesis of leaves as a function of radiation and temperature and from the architecture of the canopy of leaves (Duncan et al.1967). Later simulations have incorporated more details of metabolism, the transpiration of water, and the depletion of water in the soil, and they have calculated growth (Loomis et al. 1979). Although imperfect, simulations are logical assemblies of relevant data, and C. Sakamoto used Maas and Arkin's (1980) simulation to calculate the consequence of climatic change on wheat, as discussed below. Like the regressions above, this simulation does not include the direct effects of CO2 on plants.

Sakamoto simulated the yields of wheat during 1949-80 in nine districts in North Dakota (Fig.2). The variety of wheat, the planting date, and the quantity of and capacity for water in the soild were specified for each year. Solar radiation was estimated from the observed temperature and precipitation. The simulation calculated daily evaporation, photosyntnesis, and its allocation to the grain, leaves, and growth of the plants.

The simulated median yield for 1949-80 is less than the average for North Dakota spring wheat in Table 2 and the simulated decrease of 200 kg/ha is more than the 177 estimated from the regression coefficients of Table 2. Given the impefection of simulations, however, the degree of agreement between the two methods is more reassuring than disappointing. The actuality incorporated in the coefficients of Table 2 and the resulting 12% predicted decrease in yield are supported by similar conclusions from the simulation.

The changes in yield in the warmer and drier climate projected to follow an increase in atmospheric CO2 have now been forecast by two orderly, explicit, and objective means. Much work remains to be done: examining all the regression coefficients, simulating yields for maize and soybeans, combining the direct effects of CO2 with the changes in weather examined in Table 2 and considering changes in varieties and locations of crops. Despite the fog of caveats, a conclusion does shine through. The warmer and drier climate would decrease yields of the three great American crops over the entire grain belt by 2-12% tempering any direct enhancement of photosynthesis by higher levels of CO2.

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Pathogens and insect pests

In addition to what may be only a modest effect on a crop, changes in the weather can cause an agricultural disaster with the addition of a third party, a pest. In 1970 such a third party intervened during a warm and moist summer in the midwest, and an epidemic rather than a bumper crop was produced.

Before weather can evoke an epidemic, a susceptible crop and a virulent pest must be onstage. The crop in 1970 was vulnerable because most of the 27,000,000 ha of American maize were planted to seed that inherited its cytoplasm from a single male-sterile plant from Taxas; producing the hybrid seed by male sterility was less expensive than other methods. The virulent pest appeared when a formerly obscure fungus, Helminthosporium maydis, produced a new race and swept across entire states. Other diseases, insects, weeds, and even the jackrabbits mentioned at the beginning of this paper can also amplify the effect of changed weather (NRC 1976).

Changes in pests during a short period of time can be forecast, and mathematical regressions and simulations have been composed to study their effects (Burleigh et al. 1972, Waggoner et al. 1972). Some even simulate the altered yield of the crop in addition to the new number of pests (miles et al. 1974). These models can show how a pest will change with the weather-if still other parties are not involved.

History shows, however, that pests are so varied and variable that new and surprising types will emerge frequently. A quantitative calculation for a given pest would impart a misleading certainty to a forecast of a decade or longer. Instead, we must expect to encounter novel pests and control them as they arise, or the above calculations of changing crop yield will be rendered useless.

Adapting to a new climate

One way to adapt to drier and warmer conditions is to grow different varieties or even different species of crops, using different methods of planting and different regions for farms are other possible responses to changes in the weather. Farmers have traditionally adapted to new conditions, and future farmers with more mobility, technology and knowledge will surely adapt even faster. The safest prediction of any that I can make is: farmers will adapt to climatic change, exploiting it and making the preceding predictions too pessimistic.

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A crop can be rapidly moved from north to south, and even modifying the breeds of crops is a relatively quick adaptation. Because new varieties are bred and tested outdoors, they are already acclimatized and the lengthy process of measuring weather, discovering mechanisms of drought resistance, and engineering the genes is bypassed. For instance, the maize hybrids developed during 1930-70 resist drought better than open-pollinated maize (Russell 1974).

Drier conditions can also be made less harmful by storing more precipitation and using the stored water more productively. During the twentieth century more thorough weeding and less tilling have decreased the loss of soil moisture, and leaving more stubble in the fields has meant more precipitation was captured. Together these changes doubled the proportion of precipitation stored. Because evaporation from a productive crop is little more than from plants that merely shade the ground, increasing the yield per hectare, perhaps by applying more fertilizer, can put stored precipitation to a better use (Greb 1979).

Moving is a final and major adaptation. From 1944to 1978 the irrigated cropland in California increased by 1, 480,000 ha. At the same time the land in California used to grow commercial vegetables for the fresh market increased by 80,000 ha, while that in the Atlantic states of Georgia, tne Carolinas, New Jersey, and New York decreased by 76,000 If the climate became drier, this trend of moving to the sun and warmth of California might be replaced by a move to the humid Atlantic states, which until recently produced vegtables successfully for the may nearby consumbers.

The direct effects of CO2 on plants, the side effects of a warmer and drier climate and more pests, and various startegies of adaptation have been examined. What will be the net effect on crop yield? Although answering seems foolhardy rather than courageous, some important facts are clear. The direct effects of more CO2 in the air are beneficial: increase CO2 around a prosperous leaf, and it will assimilate more carbon and lose less water. The indirect effects of the climatic change, on the other hand, are slightly harmful in the American grain belt, even in the northern portion. While CO2 directly narrows stomates and reduces the need for water it is expected to increase rainfall and increase evaporation. Finally, although pests will change, it is impossible to predict exactly how they will do so.

This conservative forecast of countervailing effects influences. Any estimates of how much CO2 there will be in the air: Some CO2 from smokestacks and exhaust pipes can dissolve in the ocean, tempering the increase in atmospheric CO2. In real plants in cornfields and forests increase their photosynthesis along the curves observed i

laboratories and eventually become wood or organic matter in the soil, they would have a similar effect. Unfortunately, if calimatic changes prevent the rise in yield expected from the laboratory experiments, vegetation wil be less of a brake on increasing atmospheric CO2.

Thus, in the end one sees that the effects on plants of the changes in levels of CO2 and weather foreseen for A.D. 2000 are modest, with some positive and some negative. The answer to "Shall we have more or less food? is: yields should continue to increase, with the usual annual fluctuations around the trend, as scientists and farmers adapt crops and husbandry to slowly changing weather.

(American Scientist, 72, 2 (March-April, 1984) pp 179-83)

SEEDS OF PLENTY - THE PROMISE OF BIOTECHNOLOGY

by Yuri Ovchinnikov*

Over the past twenty-five years, total world agricultural production has doubled. Nevertheless, the problem of ensuring adequate nourishment for the world's growing population is still exceptionally acute. The Director-General of the Food and Agriculture Organization of the United Nations (FAO), Edouard Saouma, recently declared that if present rates of impoverishment in the developing countries continue, the number of people suffering from hunger in the world will reach 750 million in the year 2000. But at nearly 500 million, 30 per cent of whom are children under ten years old, it is already quite high enough and is fraught with serious risks for the physical and mental development of future generations.

In an uneasy world, the food problem is aggravated by a series of social, economic and political factors, from the unequal or to be more exact, inequitable distribution of goods to the often primitive conditions of production and processing of agricultural output. It is impossible today to achieve an increase in production yields per hectare of land, per head of cattle, or per ton of raw material unless advantage is taken of the latest scientific discoveries.

Nowadays production, including agricultural production is becoming a science in its own right, with its own theoretical applied, practical and inventive aspects. The very development of agriculture, for instance, has led to many scientific discoveries such as fertilizers, insecticides, new means of plant protection, new species and varieties of farm animals and crops. All man's inventiveness was required to solve the problems of supplying water to farms and meeting their energy needs. Science -largely the biological sciences-has enabled agriculture to obtain record harvest yields, to produce strains of livestock of previously undreamed-of productivity, and to bring about "green revolutions".

In recent years work has intensified in many countries in the fields of cellular biology, physiology, the biology of growth, ecology and, above all, in those branches of physics and chemistry concerned with the study of the vital processes of organisms at the level of their molecular structures. The improvement in agricultural productivity is in large part due to genetics, to which we are indebted for many valuable varieties of plants, strains of livestock and productive families of micro-organisms.

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Between 1976 and 1980, for example, in the USSR alone, 723 new agricultural plant varieties were perfected and introduced to certain regions of the country noted for their unfavourable climate and which statistics show to be characterized by far from propitious weather conditions during the planting and harvesting periods. A further 3,000 varieties were sent for quality testing at State experimental stations.

At the present time, Soviet scientists are busy working out theoretical bases for the selection of methods of creating new varieties, such as mutagenesis induced chemically or by irradiation, polyploidization and hybridization, and the preservation of genotypes.

Thanks to the chemical mutagenesis method, more than a hundred varieties of wheat, rice, oats, maize, sunflower and other crops have been obtained.

The advantage of this method is that it makes possible the production of completely new forms, previously unknown in plant-breeding, which are resistant to various diseases. From the hybridization of two mutants of sunflower, for example, one which synthesizes oleic acid in place of linoleic acid thus making its oil similar to olive oil, and another having a short stalk which enables a marked increase in sowing density to be achieved, a new strain with a yield capacity of up to 4,000 kilograms per hectare has been obtained. Furthermore, by using irradiation techniques, scientists in the USSR have produced a more productive variety of spring wheat and more than fifteen resistant varieties of cotton plant.

Research development in the field of genetics, selection and pedigree breeding is of the utmost importance for improving productivity in cattle. Among achievements in this field mention should be made of the acclimatization and propagation of the Touvinian yak. Yaks are now being introduceed to central Yakutia and it is proposed to breed them later in the Urals and the Far East. Highly productive breeds of sheep have also been created which are adapted to Siberian conditions and to conditions prevailing in the high mountainous regions of Kazakhstan. Work is also proceeding on the cross-breeding of the Russian black breed of meat cattle with the Azerbaijanian zebu.

A new branch of biology, biotechnology-and, in particular, genetic and cellular engineering-opens up unprecedented prospects. Scientists in countries that lead in this field have reached the stage at which it is possible by following a preconceived plan, to obtain new organisms with valuable characteristics; they have, in fact, become manufacturers of new living systems. Ten, or even five, years ago, such achievements were possible only in the domain of the simpler micr(-)organisms, and many laboratories throughout

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the world has made brilliant use of these methods. Today, however, plants and animals are also the subject of experiments which are giving spectacular results.

The cultivation not only of plant cells and tissues but also of isolated protoplasms has become a reality. This makes it possible to overcome physiological incompatibility in the cross-breeding of widely differing plant species. This method involves fertilization in test tubes and the cultivation on artificial nutrient media of isolated embryos and seed-buds of hybrid combinations where there is incompatibility of the parent stock. Cloning of new varieties has made it possible to achieve a threefold or fourfold acceleration of the reproduction span for perennial plants. In this way they become immune from disease and-under certain reproduction conditions-from viruses. Modifications of this kind in the selection process to which reference has been made earlier, are possible for those agricultural crops (rice, potatoes, tomatoes, lucerne, clover, rape, etc.) whose passage from cell to plant is familiar to biologists.

In experiments with mulberry Bombax, Soviet biologists have been the first in the history of science to succeed in obtaining,on an unlimited scale, genetically identical twins and perfect genetic replicas both of father and mother. A selection scheme has been devised which makes it possible to breed separate individuals in millions of copies remarkable for their productivity, and to reproduce their unique posterity in a series of generations. The problem of sex regulation has been resolved--male silk-worms give 20 per cent more silk than males and females taken together. The application of sex regulation methods to agricultural pests could open up new possibilities in the fight against agricultural production losses.

As well as the question of pests-one of the great scourges of agriculture which not infrequently causes enormous losses--mention should be made of the counter-measures against plant and animal diseases, in particular the highly purified vaccines which the USSR provides for many countries.

Special mention should be made of two new methods which have a great future. The first, which has been successfully employed in the diagnosis of virus diseases in particular, is hybridomic engineering-now just as popular as genetic engineering. Scientists have learned how to create hybridomas (cells obtained from lymphocytes and special cancerous cells) which grow at great speed and produce only one previously ordered antibody (in contrast to the multiplicity of different antibodies

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produced by lymphocytes when a pathogenic agent attacks an animal organism). The second method, recently discovered, offers even greater future prospects. It consists of the use of synthetic preparations (antigens) which are already being referred to as the vaccines of the twenty-first century.

Among the biological methods of combating pests and vectors of infection, the use of pheromones (sexual attractants of insects and other animal species) seems to be very promising. According to WHO statistics, a single grey rat devours up to 30 kilograms and spoils about 150 kilograms of foodstuffs per year, and there are seven thousand five hundred million of them in the world. Pheromones of rodents make catching operations in storehouses several time more efficient.

Another important trend which promises substantial results concerns biochemical methods, especially the study of the polymorphism of albumens. The variability of such important characteristics of plants as productivity grain quality, resistance to frost, resistance to diseases, is closely related to variations in albumens. A close analysis of the composition and nature of these albumens makes it possible to predict results accurately and to select the best varieties.

In resolving such an important agricultural problem as the production of fodder, albumen insufficiency can be reduced by industrial production of valuable fodder additives obtained by micro-biological synthesis. The scientific basis for such production and a powerful microbiological industry have been created in the USSR. At the present time, experts are engaged in converting the production of fodder protein from oil hydrocarbons of the paraffin type to other raw materials- methanol, methane, natural gas and waste from the timber, food and other industrial sectors. The utilization of wood sawdust and straw, for instance, yields biomass with an albumen content of up to 20 per cent. A means of obtaining consistently high percentages of amino acids by genetic engineering methods has been patented in the USA.

The preservation of stocks of genes (meristems, cells, pollen) of different kinds at a temperature of (-196)° in liquid nitrogen may become an important new method. The genetic apparatus of plants will itself gradually become subject to genetic engineering. In many laboratories in a number of countries, including the USSR, work is being conducted on the introduction into plants of nitrogen-fixing genes found in tuberous micro-organisms living in symbiosis with leguminous plants, and also of groups of genes responsible for resistance to viral diseases.

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While it is obviously impossible to cover the entire field of activity in the biological sciences in such a cursory survey, the problem of soil science cannot be overlooked. Soil is the essential basis of agriculture and without good soil the highest-yield or most productive varieties or strains are of no avail.

Although 14 per cent of the world's agricultural land is in the USSR, more than half of this is situated in climatically unfavourable areas and there is not all that much fertile land. Considerable areas are exposed to wind and water erosion and to salinity. These factors determine the direction of scientific research. Agricultural soil protection systems have been devised and introduced on more than forty million hectares of land. This has made it possible to obtain millions of additional tons of grain annually, to reduce the negative effects of drought and to protect the soil from erosion.

Aerial surveys to determine soil humidity, water-table levels, biomasses of a series of agricultural crops for a given quantity of electro-magnetic radiation of the soil surface in an ultra high frequency wave range, have proved their value. These investigations have demonstrated the great efficacy of teledetection methods for verifying the condition of soil resources, appraising the growth and ripening of crops, selecting objectives for land improvement, detecting disease in agricultural crops, determining the condition of large tracts of forest, and many other operations.

THE FUTURE OF MITOCHONDRIAL RESEARCH

by Michael Yaffe and Gottfried Schatz

During the past three decades, research on mitochondrial function was generally based on the tacit assumption that mitochondria are self- contained biochemical mechines fed by small molecules from the cytoplasm. This classical model of mitochondria originated with the early biochemical studies of isolated rat-liver mitochondria which suggested that these organelles could carry out all of their major functions in the absence of proteins or cofactors from the soluble cytoplasm. This autonomy of function continued to be a major themeof mitochondrial research and was in harmony with electron microscopic observations which revealed mitochondria as completely closed structures surrounded by two distinct membranes. When the inner membrane was identified as the seat of electron transport, ATP synthesis and ion pumping, the outer membrane was largely ignored and mitochondrial research concentrated almost exclusively on the mitochondrial inner membrane. The discovery that mitochondria contained their own genetic system further emphasized the concept of mitochondrial autonomy.

During the past 30 years, this classical view of mitochondria has proved to be an eminently useful framework for mitochondrial research; in fact, it can still adequately incorporate such important recent findings as: (i) the essential role of H^+-movement in mitochondrial energy coupling (ii) the role of a specific uncoupler protein in mitochondrial thermogenesis (iii) detailed structural information on mitochondrial energy transfer catalysts by amino acid and DNA sequencing and high resolution analysis of two-dimensional crystals (iv) determination of the complete nucleotide sequence of mitochondrial DNAs from several mammals, including man.

Breakdown of the classical model

This classical mitochondrial model is beginning to break down. It was first challenged by cinemolographic observations of living cells in which mitochondria continuously appeared to break up and to fuse with each other. It received a further serious blow by the discovery that most of the several hundred mitochondrial proteins are coded by nuclear genes, synthesized in the cytoplasm and transported into the mitochondria. In the past two years, evidence incompatible with the model has increased rapidly.

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Many recent observations suggest that mitochondria interact extensively with other cellular structures. Although some of these interactions have yet to be characterized in detail, they include the transfer of macromolecules between mitochondria and other organelles (including other mitochondria), mitochondrial control of phenomena occurring at other cellular locations, and interactions between mitochondria and cytoskeletal elements. These new findings reinforce earlier morphological observations which suggested that mitochondria are highly flexible structures.

Genetic evidence strongly suggests that mitochondria can functionally interact with each other. This can be shown by mating two haploid yeast cells whose mitochondrial DNAs carry distinct mutations: soon after mating, the differently mutated mitochondrial DNA molecules can complement each other functionally and actually recombine physically. The interaction is most plausibly explained by fusion of the differently marked mitochondria. Even though recombination between mitochondrial genomes has not yet been found with mammalian cells, mitochondrial fusion is not limited to yeast. It has long been recognized that maturation of mammalian spermatids is accompanied by fusion of individual mitochondria into a spiral structure surrounding the sperm midpiece. There are also indications that mitochondria of adult mouse diaphragm may form a continuous 'mitochondrial reticulum' permeating the entire muscle cell. Conversely, mitochondria can also break up into smaller units; during release of yeast cells from glucose repression, a few long and convoluted mitochondria may give rise to many smaller and more regularly shaped mitochondria. In fact, growth and division of pre-existing mitochondria is the most likely mechanism of mitochondrial formation, even though this has not yet been rigorously established. Thus, mitochondrial fusion and division appear to be frequent and rapid events in living cells. How do individual mitochondria recognize each other? How is fusion regulated? Is it important for mitochondrial function? Perhaps a 'mitochondrial reticulum' can function as a power grid which rapidly equilibrates energy in the form of an electrochemical potential of H^+ between different regions of the cytoplasm.

In higher plants, the mitochondrial genome can also interact with the chloroplast genome: analysis of mitochondrial DNA from corn (Zea mays) has revealed integrated pieces of chloroplast DNA. These pieces include part of the gene for the large subunit of ribulose-1, 5-bisphosphate carboxylase and a 12 kilobase sequence encompassing the chloroplast genes for $tRNA^{Ile}$, $tRNA^{Val}$ and the small ribosomal RNA. It is not known whether these chloroplast genes are expressed in the mitochondria nor is it clear how the chloroplast DNA sequences found their way into the mitochondria. This transfer could merely be the result

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of some rare illicit fusion between mitochondria and chloroplasts; however, it could also reflect some more active, physiological interaction between these two organelles. Indeed, it has been suggested that chloroplast protein synthesis controls the assembly of mitochondrial ribosomes.

Transfer of mitochondrial DNA to the nucleus?

Can mitochondria transfer DNA to the nucleus? This question is particularly intriguing because of the widely-held view that present-day mitochondria have evolved from endosymbionts which transferred most of their DNA to the nucleus of the host cell. Early DNA -DNA hybridization experiments failed to detect homologies between mitochondrial and nuclear DNA, last year, however, the much more sensitive tests offered by "Southern blotting" with cloned DNA fragments revealed pieces of mitochondrial DNA in the nuclear DNA of organisms as diverse as yeast, sea urchins, insects and rat. The results obtained with yeast are particularly intriguing for two reasons. First, they show that the pieces of mitochondrial DNA found in nuclear DNA are inherited according to Mendelian laws and are thus, integrated within nuclear chromosomes. Second, they suggest how these mitochondrial DNA sequences might have become integrated into the nucleus; since they represent a fusion product of four non-contiguous regions of mitochondrial DNA (including parts of the genes for cytochrome b and a mitochondrial ribosomal protein), they probably arose by excision and rearrangement of mitochondrial DNA sequences followed by transposition of the resulting aberrant fusion product into the nucleus. Similar excision/rearrangement processes occur during the induction of cytoplasmic 'petite' mutants in which the mitochondrial genetic system is inactivated. In yeast (and probably also in the other cases mentioned above) the mitochondrial DNA sequences found in the nucleus are probably genetically inactive. The opposite is true of the gene for ATPase subunit IX in Neurospora crassa; this subunit is coded by a mitochondrial gene in yeast and corn and by a nuclear gene in Neurospora, Aspergillus and mammals. Yet Neurospora also carries a copy of this gene within its mitochondrial DNA. This copy is apparently silent and neither its origin nor its physiological significance are known.

In the cases mentioned so far, the 'mislocated' DAN sequences could be fossilized DNA attesting to rare events in the evolutionary past of the eukaryotic cell. In Podospora anserina, however, mitochondrial DNA sequences appear to move from the mitochondrion to the nucleus during each life-cycle. This life-cycle starts with the outgrowth of a spore, continues with the formation of a mycelium, and ends with senescence of the cells at the mycelial periphery. Senescence seems to be accompanied, and perhaps

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even caused by, the transposition of mitochondrial DNA sequences into the nucleus. Since the transposed mitochondrial DNA sequences include the genes for cytochrome c oxidase subunits I and III, their loss from the mitochondria should be lethal for this obligately aerobic organism. If this proposed mechanism of senescence can be confirmed and extended to other organisms, it would dramatically underscore the 'mobility' of mitochondrial DNA and start a new chapter in the history of mitochondrial research.

Protein import, the cytoskeleton and surface antigens

Interactions between mitochondria and the nucleus are not limited to occasional exchanges of DNA. Mitochondrial biogenesis must require a continuously operating regulatory system linking the two organelles. We know very little about this regulatory system except that it includes proteins which are coded in the nucleus, synthesized in the cytoplasm, and then imported into the mitochondria. These imported proteins are not only mitochondrial building blocks; some of them are regulatory proteins controlling mRNA processing and translation of individual mRNAs within the mitochondria. How the rate of protein import is controlled, and which signals pass from the mitochondria to the nucleus, is a complete mystery.

The intraction between mitochondria and the cytoskeleton is emerging as another fascinating problem. Mitochondria exhibit saltatory motion and often occupy specific intracellular positions which correlate with the microtubular network. High-resolution electron micrographs of rapidly frozen nerve cells reveal characteristic cross-bridges between neurofilaments and the mitochondrial surface. While such morphological findings are inherently difficult to interpret, they suggest that mitochondria are tethered to the cytoskeleton and that this association controls mitochondrial movement. Indeed, there exists tentative evidence that, in budding yeast, the movement of mitochondria into the bud can be rendered temperature-sensitive by specific nuclear mutations. Similarly a (presumably nuclear) mutation in the nematode Caenorhabditis elegans appears to alter the intracellular location of portion of the mitochondria, and the mislocated mitochondria have a more rounded shape than their correctly positioned counterparts. All these observations suggest that mitochondria do not move in the cytoplasm by random diffusion, but via specific interactions with the cytoskeleton. These interactions have so far escaped detection by bio-chemical methods, but they could perhaps explain why, upon cell fractionation, a large percentage of the mitochondria is lost in a rapidly sedimenting fraction.

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An astonishing recent finding is that mitochondrial DNA controls the expression of a cell surface antigen. Two indepedent laboratories found that, in inbred strains of mice, expression of a class I component of the major histo-compatibility complex is meternally controlled and correlated with a sequence difference in the corresponding mitochondrial DNAs. The structural gene for this antigen is probably located in a nuclear chromosome, but its expression must somehow be controlled by the mitochondrial genome. Since mitochondria do not seem to export any mitochondrially-coded polypeptides it is difficult to explain how mitochondrial DNA could control the expression of an antigen located on the surface of the plasma membrane. This interaction dramatically illustrates the limits of the classical mitochondrial model and shows that we still know very little about how mitochondria interact with other components of the eukaryotic cell.

Since most of these interactions are lost when the cell is disrupted, they are difficult to study by conventional biochemical methods. One promising approach is to study the mitochondrial outer membrane since most of the phenomena discussed above are probably mediated by outer membrane proteins. Isolation of sealed outer membrane vesicles having a unique polypeptide composition and the cloning of the genes for several of these polypeptides may help in such studies (M. Suissa, unpublished results).

A second approach is offered by genetics. As a step in this direction, we are attempting to identify genes necessary for mitochondrial assembly in yeast. So far, we have isolated several mutants in which mitochondrial assembly has been rendered temperature-sensitive by single nuclear mutations (M. Yaffe and G. Schatz, submitted). The study of such mutants could shed further light on some of the interactions discussed above and could uncover new interactions that are entirely unexpected.

A view of the eukaryotic cell is emerging in which mitochondria interact structurally, functionally, and biosynthetically with other cellular components, Many of the examples discussed above are based on preliminary observations, but together they hint at the variety and complexity of these interactions. We suspect that mitochondrial research will focus increasingly on these processes, their role in cell function, and their underlying molecular mechanisms. The biochemists' preoccupation with isolated mitochondria has led to a conceptual isolation of mitochondrial from their surroundings. Mitochondrial research of the future will restore the mitochondrion to its place in the eukaryotic cell.

(Trends in Biochemical Sciences, 9,14 (April 1984) pp 179-181)

THE GENETIC MANIPULATION OF CROP PLANTS

by Ben Miflin and Peter J. Lea

Two recent UK symposia devoted to the genetic manipulation of plants addressed the same question: 'what has it done for agriculture?. The superficial answer might be:'so far, not much'. But that would be to misunderstand the long-term nature of crop science. Bear in mind, for example, that although the initial cross in the production of the currently successful wheat cultivar Avalon was made in 1969, the variety was only ready to be released in 1980- a period that more than econompasses the whole history of recombinant DNA technology. Moreover, the amount of information available and the number of systems under study are already impressive compared with what was known and foreseen five years ago. What then has been achieved?

For a start, recombinant DNA techniques for gene isolation have been applied to a wide range of crop species The work has centred on the genes for the most abundant proteins, such as ribulose bisphosphate carboxylase, an enzyme of the carbon-fixation cycle, and the seed storage proteins of cereals and legumes. From this, a pattern of organization is emerging in which each major group of cereal proteins is encoded by one or more complex multigenic loci, the individual genes of which contain a number of different tandem and interspersed repeats (B. Forde et al., Rothamsted). The genes themselves, particularly those of the legume storage proteins, appear to have a conventional structure of coding sequences interspersed with introns (D. Boulter, University of Durham). Currently the flanking regions of various plant genes are being searched and tested for sequences that are important in controlling the expression of genes particularly in response to environmental stimuli such as stress or light.

Although the study of plant protoplasts is expanding and the list of species that can be regenerated from protoplasts grows ever larger, monocotyledonous species are notable by their absence and techniques producing large number of regenerants at high frequency have only been worked out for very few species. Protoplasts are potentially valuable for at least three reasons. First, new genes can be introduced into plants through protoplasts, who socultivation with Agrobacterium appears to be an efficient way of going about the task (J. Schell et al., Max-Planck-Institut Koln). Second, the selection of plant mutants by screening protoplasts is, in theory, valuable. It has, for example, led to mutants deficient in nitrate reductase (R. Mendel and A. Muller, Akademie der

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Wissenschaften, Gatersleben, GDR), but in general the technique has been somewhat disappointing and many workers have turned to other methods, Third, protoplast fusion offers a way of combining species that are not sexually compatible.

Although progress in the development of protoplast and tissue culture techniques has been slow and frustrating the techniques have an immediate application Micro-propagation of high-value cropsis of increasing use in the horticultural industry (G,Hussey, John Innes Institute) and there is considerable interest in the exploitation of the variation (somaclonal variation) induced by passage of plants through protoplast or tissue culture and the use of issue cultures in the manipulation of ploidy (D. Ingram et al. University of Cambridge) Hundreds of lines of potato and wheat plants derived from culture are being evaluated by state and commercial breeders.

The application of precise gene transfer to yield new cultivars seems some way off, even though crop plants such as potato have been successfully transformed and taken through a tuber generation (G. Ooms) et al. Rothamasted). The reason is the absence of genes, and even of the knowledge of which genes, to transfer. Since this problem stems largely from gaps in understanding of plant biochemistry, many of the techniques described above are being used to investigate aspects of plant metabolism.

Nitrogen and carbon metabolism have been the first to be attacked. The contribution of the Rhizobium genome to nitrogen fixation in the root nodules of legumes is being analysed rapidly and genes for fixation, nodulation and symbiosis have been characterized (J. Downie and A. Johnson, John Innes Institute, and see these columns in Nature 306, 639; 1984). Plant genes involved in the symbiosis that have been isolated include that for leghaemoglobin (D. Collinge et al., Aarhus University) and more recently, glutamine synthetase (J. Cullimore et al., Rothamsted). Cloning of other genes important in nitrate and ammonia assimilation is reasonably advanced only in prekaryotes (J. Wootton, University of Leeds). Genes for both subunits of fribulose bisphosphate carboxylase have been isolated; since that for the large subunit can be expressed in Escherichia coli, the way is open to explore structure- function relationships through in vitro- mutagenesis (R. Ellis, University of Warwick, and A. Gatenby, Plant Breeding Institute). Directed in vitro mutagenesis affecting the active site of the single-subunit carboxylase of Rhodospirillum rubrum has already been achieved (S. Gutteridge and G. Lorimer, Du Pont de Nemours, Wilmington) Nitrogen and carbon metabolism have also been investigated with defined biochemical mutants. This has led to a better understanding of the pathways and their regulation as well as to new lines of barley with greater amounts of nutritionally essential amino acids in the seed (S. Bright et al., Rothamsted).

Another active area of molecular biological investigation is the level at which genes are controlled in the defence mechanisms of plants against disease and stress as well as in the normal development of plants. For example, considerable progress has been made in identifying mRNAs involved in the early steps of phytoalexin (Plant fungicides) biosynthesis (K. Hahlbrock et al., Max-Planck-Institut, Koln), and the heat-shock proteins of plants and their mRNAs have been identified (F. Schoffl et al., Bielefeld, FRG and Athens, Georgia). In both systems the synthesis of mRNAs appears to be largely controlled at the level of transcription. Other systems, yielding equivalent information, include the induction, by light, of the genes of certain chloroplast proteins (T. Gallagher et al., University of Warwick) and the activation of genes involved in fruit ripening (D. Grierson et al., University of Nottingham).

In summary, despite the activity and considerable progress reported, the genetic manipulation of crop plants is still only getting underway. For the present, improvements in agricultural plants will continue to come from that older and well-established technique of genetic manipulation, plant breeding. This technology (as described by J. Bingham, Plant Breeding Institute) is highly sophisticated: it can safely be predicted that the earliest successes of the recombinant DNA approach will enhance that sophistication rather than replace it.

(Nature 304, 5929 (April 5-11, 1984) pp 498-99)

ROLE OF THE RECOMBINANT ADVISORY COMMITTEE

by Irving S. Johnson

Recombinant DNA technology has been developing in an unprecedented scientific-public forum atmosphere in which the transfer of new basic scientific knowledge to the realm of practical commercial use has been extremely rapid. During this time, the scientific community has turned to the National Institutes of Health for help in organizing a Reombinant Advisory Committee (RAC) with the expertise to deal with the scientific and technical questions raised by the research as well as to ensure that the public interest is responsibly represented. In its several years of existence, RAC has established expertise among its members advisers, and consultants that is unparalleled in its ability to deal with the complex problems in recombinant DNA technology.

The high level of public service rendered by the committee in its consideration of recombinant DNA applications has provided for protection of the public health and the environment. In addition, current public policy which blends scientific oversight through RAC with voluntary adherence by industry and other non-NIH funded parties has fostered technological innovation and U.S. leadership in genetic research. Starting in 1979, RAC reviewed complex industrial submissions in closed sessions, much as NIH continues to do with research grant proposals. This practice has decreased since most recombinant DNA research no longer falls under the guidelines as they have evolved. This diminished requirement for RAC oversight hardly justifies a need for redundant statutory regulation. Furthermore, deemphasizing the contribution of NIH and RAC in oversight and review could create public concern and lead to controls inconsistent with public health needs, scientific progress, and the national interest.

A number of firms and all regulatory agencies and Cabinet-level departments have commented in support of the current activities of RAC; so, too, has the American Society for Microbiology, which probably includes the majority of the individual practitioners of the technology. Too frequently, government and industry become adversaries. RAC's review procedures enable industry, government, and academia to work together effectively and to produce fruitful research without encumbering those involved in the research with a regulatory process that is not needed to preserve public safety. This, too, is in the public and national interest.

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If a significant concern is the need for more direct input from the regulatory federal agencies, their non-voting representatives on the committee could be charged with submitting formal comments on proposals whose implementation would fall within the jurisdiction of their agencies. Duplication of the functions of RAC among several federal agencies has thus far been avoided. The public interest is well served by continuing to have a single review group with the demonstrated capability to deal with the complex but assessable problems presented by recombinant DNA research.

Because of the universal applicability of the basic concepts of recombinant DNA, the activities of RAC should not be confined to the biomedical field. Members to the committee with expertise in areas such as epidemiology and microbial ecology could be added to the committee as needed. To create additional independent committee would simply increase communication difficulties; the organizational redundancy would place further strain on our available intellectual resources. Additional structures would only create delays in a scientific endeavor that requires a highly efficient review process to keep up with the expanding knowledge base as well as to maintain a fragile competitive advantage internationally.

The track record of the RAC clearly shows its usefulness to the scientific community and to the public. Moreover, the universality of recombinant DNA research-like that of the genetic code upon which it is based-argues for a single and unified oversight system. RAC's oversight should continue until that time in the not too distant future when there will be little left for it to oversee.

(Science, 224 ,4646(April 20, 1984) p.243)

CHILDREN IN PERIL

by V. Ramalingaswami*

The British economist Barbara Ward spoke of two environments - " the inner environment of Biological health, full creativity and mental development and the outer environment of culture, stimulus and beauty of shared affection and civil security". How can bring about a harmonious development of these two environments for the world's children ?

Developing countries are not a homogeneous entity. They are at various stages of socio-economic development, and are developing at various speeds, but they all face one most important problem-high infant and child mortality rates and morbidity. In India for example the infant mortality rate is around 129 per thousand live births, more than 50 per cent of infant deaths occur within the first month of life, and low birth weights are found in almost a third of all births. For mothers under twenty years of age, the birth weights are significantly lower than for mothers from twenty to twenty-four years of age. The frequency of low birth weight increases with rising birth orders.

The story of infant and child health in the Third World is one of needless illnesses, of avoidable disabilities and of missed human opportunities. Acute diarrhoeal disease is the leading cause of death in children under one year of age. Malnutrition, overcrowding, lack of protected water supplies, poor environmental sanitation and low levels of education all act together in a vicious cycle.

When oral rehydration with glucose-salt mixture is instituted early, the death rate from this group of disorders can be brought down dramatically within a short period of time. One oral rehydration solution can now be used to treat most cases of watery diarrhoea, irrespective of the causative agent- virus, vibrio or bacterium. The goal is to make oral rehydration therapy a home remedy so that in the not-too-distant future the bulk of diarrhoeal diseases may be no more than a mere nuisance managed by the mother themselves in their homes.

Many factors combine in the form of a chain reaction to prepetuate protein-energy malnurition as one of the most endemic and intractable nutritional disorders of the Third World. These factors include deficient intake of food, diarrhoea and other common childhood infections, the attitudes and perceptions of mothers, traditions and taboos with regard to infant feeding practices, and poverty with all its ramifications.

*Director-General of the Indian Council of

This vast problem has still not been tackled effectively. The supplementary feeding programmes of the past few decades have had remarkably little success in bringing about lasting changes in the attitudes of mothers towards providing the best possible nutrition for their children. Protein-energy malnutrition is a problem that calls for coordinated multi-sectoral action to deal with the convergence of poverty and unemployment, of disease and illiteracy accentuated by rapid population growth. These issues economic distortions, human inequalities and social injustices.

Action should be carried out within the health sector to provide a package of integrated services wherein nutritional and health care services, especially infection control measures, are combined. Efficient surveillance, early diagnosis and simple treatment of common childhood infections can be carried out by village volunteers and mothers, who should be regarded as first among front line health workers.

Certain illnesses can be remedied by simple and inexpensive "magic bullets".

- Nutritional blindness affecting young children is a problem that can be resolved by increasing the intake of either preformed vitamin A or of pro-vitamin A in the form of green leafy vegetables as a regular part of the diet. Pending this long-term solution, it has been shown by Indian workers that giving massive doses of vitamin A every six months to children under the age of five is a feasible method of controlling this deficiency.

- Endemic goitre which afflicts an estimated 200 million persons, mostly in the Third World (including 40 million in India alone) can be treated by the simplest and cheapest public health measure known to man-iodized salt. Injected or administered orally, iodized salt will not only control goitre but when given to pregnant women will eliminate the developmental disorders of deaf mutism and crétinism which are associated with severe forms of iodine deficiency. But in spite of their cheapness, programmes to control goitre are not working effectively in many parts of the developing world.

- Nutritional anaemia is essentially the result of an iron deficiency which can be [illegible] by a periodical supplementation of the diet with an iron-containing tablet or, as has been shown by Indian workers, by the fortification of [illegible] with a small quantity of iron.

It is in the application of what we know that we are failing more than in the discovery of new knowledge. We need

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to carry out serious social science research in order to identify the behavioural factors which influence the acceptance and diffusion of a given technology. The health history of the world teaches us that there is a direct relationship between imporvement in socio-economic status and reduction of infant mortality rates. It is futile to believe that a health system can function outside the overall developmental processes. The maximum health benefits can be derived from development when health activities are integrated into activities in other sectors.

In the Third world experience during the past two decades has shown that with able leadership, well-designed and effectively operated programmes, appropriate technologies and forms of health-care delivery together with professional back-up support, infant mortality rates can be reduced by 50 per cent or more even by poor countries in a relatively short period of time and at a cost less than the equivalent of 2 percent of annual per capita income.

The most important nutrition problem in developing countries affecting infants and young children is that of protein energy malnutrition. Most frequently this occurs as the complex result of an inadequate diet in a deprived environment. Families often do not have sufficient knowledge of the nutritional health needs of infants and small children.

Once the nutritional status of a young child starts to deteriorate a vicious circle of malnutrition and infection is set up. Infections interact with nutrition by decreasing the resistance of the young child, by lowering his normal food intake and by diminishing utilization of nutrients from the food. A large number of children can be expected to be suffering from an acute or chronic infection during considerable part of their first years of life.

Other nutritional problems arise from specific vitamin and mineral deficiencies. The principal problems are associated with lack of Vitamin A and Vitamin D, and the mineral salts iodine and iron/folate. Severe lack of Vitamin A in the diet gives rise to blindness and the disease is known as xerophthalmia. Lack of Vitamin D causes the disease known as rickets which affects the bones of the body and causes bending of the long bones in particular. Lack of mineral salt iodine causes endemic goitre, and lack of iron in the diet gives rise to nutritional anaemia. Anaemia may also occur as a result of lack of folic acid in the diet and is usually combined with lack of iron.

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Nursing mothers and young children are the most vulnerable to Vitamin A deficiency, especially if they live in areas where the staple food used for the weaning diet consists primarily of rice, maize or cassava and where small amounts of animal foods, leafy vegetables and fruits are eaten. Xerophthalmia is called a "disease of darkness" because an early symptom is nightblindness or difficulty in seeing in dim light. This eye disease is prevalent in Asia, Africa, South America and the Caribbean. Once the sight has been destroyed, and this can happen with great rapidity, nothing can be done to restore the child's vision.

Yet in most countries where this blinding malnutrition is serious there exists a cheap supply of Vitamin A, in green, leafy vegetables. Because of custom and ignorance, many of these vegetables are not introduced to children's diet by the mothers or other caretakers of the children. The task is to persuade them to do this through nutrition education.

Fat is needed for the absorption of a substance called carotene which is found in the green leaves and from which the body manufactures Vitamin A. The carotene taken by the mouth in the green vegetables may not be absorbed into the blood and does not reach the body cells if the weaning diet is lacking in fat. Palm oil, cottonseed oil and other food oils locally available can be used to mix the staple food which is the basis of the weaning diet for the baby.

Rickets is caused by a shortage of Vitamin D, together with a poor diet, so that there is not enough calcium present in the blood stream for calcification of the bones. If the bones are not properly calcified then they remain soft and wh the baby begins to walk the leg bones bend under his weight. Rickets again is a child's disease and is highly endemic in some regions of the world. Cases of rickets are not usually fatal but the deformities can be permanent. Bow legs or knock knees are only one symptom of rickets. Vitamin D can be supplied from such foods as fatty fish and eggs. It can also be made in the skin under the influence of ultra violet light from sunshine. Exposure of the child's body and limbs to afternoon sun in the tropics can heal and prevent symptoms of rickets. Milk powder and baby foods, as well as margarine, enriched with Vitamin D should be utilized.

Endemic goitre is a widespread disease and has been reported from all areas of the world. It appears in early childhood and progresses into adolescence and sometimes adulthood. Women of childbearing age are of particular concern. Goitre is caused in some areas by a deficiency of iodine in the soil and water. Iodized salt has been proved successful in eliminating goitre in different regions. The total population under risk is estimated at 400 million.

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Nutritional anaemia caused by iron deficiency is probably the most common form of specific nutritional deficiency in the world today. It affects mainly young children and women of child-bearing age. Evidence also suggests that nutritional anaemia adversely affects the productivity of workers. Iron is needed to form blood. People who suffer from anaemia cannot supply enough oxygen to their tissues. They are lethargic, sluggish and easily fatigued. They lack concentration, get out of breath on even slight exertion and lack vitality. Anaemia occurs when there is a prolonged loss of blood, or failure of absorption or a dietary shortage over a very long period.

Sucklinn anaemia has been known in many parts of the world. Babies in tropical areas may have a low haemoglobin count as early as three months of age. Normally the baby receives enough iron from the mother for the first six months of life, but if the mother has suffered from iron deficiency in the last months of pregnancy, the baby does not get its full quota. Poor absorption of iron may account for some of the deficiency. Frequent attacks of malaria and parasitic diseases will cause a temporary anaemia. This will pass if the child is receiving enough protein and iron in the diet.

Anaemia due to deficiency of folic acid may also occur. It is less frequent and usually combined with iron deficiency It is generally associated with pregnancy. Folic acid is a problem nutrient. There are very heavy demands by the body for this vitamin during pregnancy when the diet has to provide four to eight times as much as the normal quantity required. Folic acid is a water soluble vitamin of the B complex and is needed for blood cell formation as well as protein production in the body. It also contributes to the formation of the material of which chromosomes, the genetic mechanism of cells, are composed. Good sources of folic acid are: yeast, liver, spinach and lettuce. Poor sources which nevertheless make some contribution to the diet are milk, poultry, eggs and meat. A larger consumption of animal products is needed, and a decrease in the infestation rates with parasites that cause loss of iron from the food and system.

X-RADIOGRAPHY IN THE PRESENT DAY INDUSTRIAL WORLD

By D.K. Bhattacharya & Baldev Raj

(Abstract)

X-radiography is one of the major non-destructive test techniques used for inspecting industrial components today. In the present evolution of X-radiography, it would be seen that newer techniques being incorporated in it, are meant mainly to remove the disadvantages. Some examples are real time radiography, high resolution radiography, tomography and image enhancement. The principles involved in real time radiography which is being used more and more for mass produced items and in those cases where a lot many X-radiographs have to be taken for a single component, is described in the paper. It is explained how the advancement in the image enhancement (i.e. image processing) in the X-radiographs has helped better performances of real time radiography. The reasons of the availability of image enhancement systems on a cost effective basis and the principles of image enhancement are also explained in the paper. Tomography which would not only find the size and shape of a defect but also its location within a component, is a hotly pursued area of development today. However, for use in the industry some limitations have to be overcome. These reasons and why medical tomography has already been a success is explained in the paper. It is also explained how the newer developments would help X-radiography technique to detect severe defects like cracks in better fashions.

(World Science News, (May 1984) p. 13)

ALBERT EINSTEIN :

Selections from and on Einstein, INSA & CSIR. 1984

In October, 1979 a special issue of Science Information Notes in mimeographed form on 'Albert Einstein' containing some select quotations and articles from and on Einstein was issued to mark his centenary. In view of the persistent and continuing demand for this number, the Academy has recently brought out its revised version in collaboration with the CSIR. Besides Seminar/ Summer Institutes, this publication is intended for restricted distribution amongst the Fellows of the Academy who may especially ask for a copy. This publication (171 pages) is available without charge. In case you wish to obtain a copy, please send your request to the Executive Secretary, Indian National Science Academy, New Delhi-110 002.

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